5. PHYSICAL CONDITIONS OF STUDY AREA AND ENGINEERING SURVEY

5.1 Physical Conditions of Study Area

(1) Topography

The topography is favorable throughout the entire Project Site. Flat land is spread out in the Red River delta with elevations at less than 10 m. The open area is mainly utilized for rice cultivation.

(2) Geology

Geologically, the flat terrain in Red River delta area is of alluvium or diluvium formation of Holocene or Pleistocene Ages, composed of alluvial or diluvial soils of gravel, sand, loam, silt and clay.

(3) Climate

Annual average rainfall in Hanoi is about 1,700 mm of which 80 - 85 % falls in the rainy season. The annual average number of rainy days is 140. Annual average temperature in Hanoi is 23.6 °C with its minimum of 4 °C and maximum 39.4 °C; mean humidity is 82 %.

5.2 Topographic Survey

Topographic survey was conducted for three (3) alternative routes comprising:

- Centerline/profile survey;
- Plane table survey;
- Cross section survey; and
- River Cross section survey

Upon completion of the topographic survey, the following was produced for preliminary design:

i) 28 sheet of topographic maps to a scale of 1/2,000 which show all the salient features such as buildings, roads, power lines, rice paddy or irrigation canal dykes, fish ponds;

ii) Centerline profiles to the scale of 1/1,000 horizontal and 1/200 vertical along the centerline of SHTRR including Thanh Tri Bridge;

iii) Cross sections for each 50 m intervals along the routes with the scales of 1/1,000 horizontal and 1/200 vertical;

iv) Ground elevations at boring locations; and

v) Topographic survey report.

5.3 Hydrological Survey

Hydrological survey was conducted to identify the hydrological conditions of the Red River:

i) Soundings for nine (9) cross sections of the Red River;

ii) Flow velocity measurement at three (3) alternative routes; (measured velocities varied between 0.8 m/sec near river-bed and 1.5 m/sec near water surface at selected route); and

iii) Analysis of hydrological data for the Red River in Hanoi area.

The following findings are obtained as a result of hydrological survey:

- The maximum design flood water level of the Red River at Thanh Tri Bridge site is elevation 12.5 m;
- The deepest river-bed to be encountered at the bridge pier locations will be at elevation -3.80, therefore, the deepest water depth at the flood stage around bridge piers is expected to be 16.3 m;
- The estimated local scouring depth around bridge piers is approximately 6.0 m.

5.4 Soil Investigations

(1) Purpose of the Investigations

The purpose of the investigations is to obtain data for the preliminary design of bridges, embankment and pavement.

(2) Field Work and Laboratory Testing

The field work and laboratory testing were conducted by a local consulting firm. The JICA Study Team planned and supervised investigations. Machine boring with standard penetration tests was conducted at 19 locations. Thin-wall tube sampling were also carried out for soft soils. Test pit sampling were made at possible sources of embankment materials, pavement materials and concrete aggregates. The laboratory testings were carried out for the collected samples.

(3) Bearing Strata of Foundation Piles

Standard penetration tests were performed for the entire 50 m depth of each boring hole at intervals of one (1) meter. Summary of bearing strata (N-value more than 50) for piled foundations are shown in Table 5.1.

Table 5.1 Summary of the Bearing Strata for Piled Foundations (N≧50)

Boring No.	Ground Surface Elevation (m)	Depth of Bearing Strata
1	6.975	38.5 m
2	4.058	37.5 m
3	4.036	47.5 m
4	9.100	38.0 m
5	-4.270	46.5 m
6	7.325	40.0 m
7	5.562	37.0 m
8	5.835	40.0 m
9	5.794	41.3 m
10	9.015	43.0 m
11	8.410	41.0 m
12	-2.900	37.5 m
13	9.607	44.0 m
14	5.795	32.0 m
15	4.679	40.0 m
16	3.717	39.0 m
17	5.436	43.5 m
18	7.431	47.0 m
19	5.396	43.5 m

(4) Borrow Materials

Many sand supplying companies are located along the shore of the Red River, where the sand is pumped from the river-bed. Table 5.2 shows the sources of embankment materials for the construction.

Table 5.2 Borrow Material Sources

Section	Sources		
	Place	River	Material
Thanh Tri Section	Linh Nam Bai Bac	Red River Red River	River Sand River Sand
Gia Lam Section	Phu Dong	Duong River	River Sand

(5) Source of Coarse Aggregates

The sources of Coarse Aggregates are shown in Table 5.3.

Table 5.3 Sources of Coarse Aggregates

Materials	Place	Rock	Los Angeles Abrasion
Coarse Aggregates	Mieu Mon Quarry in Ha Tay Province	Limestone	33 %
Coarse Aggregates	Kien Khe Quarry in Ha Nam Province	Limestone	31 %

Mieu Mon quarry and Kien Khe quarry are located about 50 km and 60 km in single trip distance from Thanh Tri area respectively.

(6) General Descriptions of Subbase and Base Coarse Materials

Subbase course materials from the Red River will require processing for gradation control, considering the nature of deposit.

A number of aggregate producers are in operation in the NH No. 1 corridor. Above mentioned Mieu Mon and Kien Khe quarries are presently producing crushed rock. The existing capacity of each quarry is 200 ton/hour and practically no limit in the limestone deposit.

(7) CBR Test Results of Base Course Materials and Embankment Materials

As the base course material, limestone from Mieu Mon, Kien Khe and Xom Van quarries were selected, and as the embankment material, the Red River sand was chosen. The test results were as shown in Table 5.4.

Table 5.4 CBR Test Results of Base Course and Embankment Materials

Source	Soil Type	CBR (Soaked)
Kien Khe	Limestone	78-100
Mieu Mon	Limestone	74-98
Xom Van	Limestone	74-96
Bai Bac	Sand	14-19.5
Phu Dong	Sand	13.5-21
Linh Nam	Sand	11.5-18

(8) Slope Stability and Settlement of Embankment Foundation

As a result of slope stability and settlement analysis it was concluded that:

- The slope of the embankment must be 1 vertical to 1.5 horizontal (1:1.5 slope) or flatter and adoption of 1:2 is recommended; and
- Sand drain with pre-loading will be required in the limited stretch of SHTRR where subsoil conditions are adverse ($N \leq 5$) and embankment height becomes higher (i.e. at bridge approaches and culvert locations).

6. DESIGN STANDARDS

6.1 Geometric Design Standards

In determining the geometrical design standards for the project, the standards of the MOT are esteemed as a base while Japanese and AASHTO standards are referred to when necessary.

(1) Design Speed

Design speed is the maximum safe speed that can be maintained over a specified section of road when conditions are so favorable that design features of road govern.

A design speed of 100 km/hr. is applied to the throughway of the SHTRR. In case of the frontage road, 40 km/hr. design speed is adopted considering good accessibility to adjoining properties and mixed traffic of motorized and motorized and non-motorized vehicles.

(2) Lane Width of Throughway

The lane width of 3.75 m is adopted based on TCVN 5729-1997.

(3) Recommended Geometric Design Standard

Table 6.1 presents the summary of major recommended criteria for geometric design of the throughway of SHTRR and Thanh Tri Bridge (hereinafter referred to as the "Project Highway") based upon the comparison and deliberation of Vietnamese standard, AASHTO and Japanese standard due to the lack of design standard for urban freeway in Vietnam. The geometric design criteria for frontage road is to comply with TCVN 4054-85.

6.2 Pavement Design Standard

Flexible pavement has been adopted in the preliminary pavement design. The thickness design of the pavement are based on the "AASHTO Guide for Design of Pavement Structures (1972 and 1986)".

Table 6.1 Design Criteria for Throughway

Items	Unit	Vietnamese Standard TCVN 5729-97	AASHTO	Japanese Standard	Recommended Standard
Class of Road		Freeway Class 100	Urban Freeway	Urban Road 2-1	Urban Freeway
Terrain		Flat	Flat	Flat	Flat
Elements of Design					
Design Vehicle		TTSC *1)	TTSC *1)	TTSC *1)	TTSC *1)
Minimum No. of Lanes		4	4	4	4
Design Speed	km/h	100	96 (60 mph)	100	100
Stopping Sight Distance	m	160	160 (525 ft)	160	160
Minimum Horizontal Curve	m	450	437 (1,432 ft)	460	450
Maximum Grade	%	5 (4) *3)	3	3	4
Minimum Vertical Curve Sag	m	3,000	3,650 (120 ft)	3,000	3,000
Minimum Vertical Curve Crest	m	6,000	5,800 (190 ft)	6,500	6,000
Vertical Clearance	m	4.5	4.27 (14 ft)	4.5	4.5
Crossfall	%	2.0	2.5	2.0	2.0
Maximum Superelevation	%	7	8	8	7
Cross Section Elements					
Lane Width	m	3.75	3.66 (12 ft)	3.50	3.75
Raised Median *2)	m	1.50		1.75	2.00
Inner Shoulder	m	1.00	1.22 (4 ft)	0.50	1.00
Outer Shoulder	m	3.00	3.05 (10 ft)	1.25	3.00

Note:
*1) TTSC abbreviates Truck Tractor - Semitrailer Combination.
*2) The width of raised median is subject to securing the space for pier of crossing grade separation structure.
*3) Bridge and approaches.

6.3 Bridge Design Standard

(1) Design Loading

Basically Vietnamese Bridge Design Code (Specifications 22 TCN 018-79) follows AASHTO specifications. Due to the reasons explained below, AASHTO load HS 20 - 44 x 125 % is adopted for design load. This load is in response to Vietnam's standard H30. With the present and projected heavy truck ratio in mind, this is an appropriate design load for the Project Bridges.

(2) Flood Clearance

Article 1.27 of Vietnam Bridge Design Code 22 TCN 018-79 was followed to determine the clearance for the design of bridges in case the river is not utilized for navigation.

(3) Navigation Clearances

Confirmed that the navigational clearance for the bridge should be 10 meters above high water level (HWL) and this should be maintained over a width of 80 meters in addition the value of the HWL should be the predicted level of the river for a return period of 20 years.

(4) Road and Railway Clearances

The clearances for the design of bridges crossing over any classes of roads were determined in accordance with the Design Criteria of Highway TCVN-4054-85.

The clearances for the design of bridges crossing over 1 meter gauge railways are as follows:

Overall width : B = 4.00 m
Overall height : H = 5.30 m

7. FORMATION OF ALTERNATIVE PLANS

7.1 Study of Alternative Routes

(1) Project Site

The Southern section of Hanoi Third Road (SHTRR) is located in Thanh Tri and Gia Lam districts, crossing the Red River 6.5 km downstream of Chuong Duong Bridge and 3.5 km downstream of Pha Den (Hanoi) port.

The beginning point of the SHTRR is located at Phap Van on National Highway No. 1 and the ending point is at Sai Dong on National Highway No. 5.

(2) Alternative Routes

Three alternatives were selected for further comparison, namely Alternatives 1, 2b and 3 (Figure 7.1):

Alternative-1	:	Shorter Bridge Length Scheme
Alternative-2b	:	Least-Affected Inhabitant Scheme
Alternative-3	:	Least Land Acquisition Effort Scheme

(3) Description of Alternative Route

A route location of the SHTRR has already been proposed in the pre-feasibility study conducted by TEDI. Referring to TEDI's route and aerial photographs taken in 1993, the following three schemes were established in the Study (Figure 7.1).

Alternative-1: <u>Shorter Bridge Length Scheme</u>

Assuming the length of Thanh Tri Bridge is identical with the distance between dykes, the shortest crossing point of the Red River is selected at the north of TEDI's proposed route (1,860 m in length compared with 2,340 m of the TEDI's route). Also, the length of SHTRR will be the shortest among alternatives, namely approximately 700 m shorter than Alternative-3.

Alternative-2b: <u>Least Affected Inhabitant Scheme</u>

The SHTRR assumes to cross the Red River at the proposed point of the TEDI's route and passes undeveloped area with minimum number of affected inhabitants.

Figure 7.1 Location of Route Alternatives

Alternative-3: Least Land Acquisition Effort Scheme

The SHTRR assumes to cross the Red River at the proposed point of the TEDI's route and make full use of existing road right-of-ways to minimize additional land acquisition effort.

(4) Traffic Capacity and Required Number of Lanes

To determine the magnitude of the construction effort, required number of traffic lanes was analysed based on future traffic characteristics.

(5) Further Studies

Further studies were conducted to provide the data for optimum route selection, concerning:

- Interchanges;
- Locations of New Highway No. 1 interchange and toll barrier gate; and
- Traffic maneuvering plan in Thanh Tri and Gia Lam area.

7.2 Study of Bridges and Other Structures

(1) General

Study was carried out for all alternative routes and broadly covered the following bridges and structures:

- River crossing bridges (Thanh Tri Bridge) ;
- Interchange structures;
- Flyovers; and
- Drainage structures and other bridges.

1) Thanh Tri Bridge

Than Tri Bridge consists of main bridge, dyke bridge and approach bridges.

2) Interchange Structures

The requirements for three interchanges have been identified, namely;

- At the intersection of the existing National Highway NH-1;
- At the intersection of the new National Highway NH-1; and
- At the intersection of the existing National Highway NH-5.

3) Flyovers

The alignment traverses a number of local roads and public footpaths and flyovers were planned to allow the public to traverse the highway in a safe manner.

4) Drainage Structures and other Bridges

The Site requires drainage structures which cross SHTRR, in particular, there are proposals for the location of a flood relief reservoir in Thanh Tri district. The Study Team envisaged that the proposed structures would be either a single or multi cell reinforced concrete box culverts or short span bridges.

(2) Initial Study of the Main Bridge of Thanh Tri Bridge

Through the initial study of a number of bridge types, the Study Team narrowed down the alternatives to the following short-listed bridge types for the main bridge:

- Alternative 1 : PC continuous Box Girder Bridge
- Alternative 2 : PC Extradosed Bridge
- Alternative 3 : PC/Steel Cable Stayed Bridge

The above three alternatives were carried forward to the next step of detailed comparison to be made based on the results of comparative design as well as economic study if required.

(3) Study of Thanh Tri Bridge, Route Alternative 2b/3

From the alignment survey the total distance between dyke embankment is approximately 2.03 km with the normal water course situated closer to the mid-point of this distance. The width of the normal water course is approximately 633 meters.

The height of the dyke embankments are:

Hanoi side : 14.03 meters
Gia Lam side : 13.30 meters

1) Main Bridge

Following bridge types are set out and initial design was made:

Bridge Type	Middle Span Length
- Continuous PC Box Girder Bridge	130 m and 150 m
- PC Extradosed Bridge	180 m
- PC/Steel Cable Stayed Bridge	260 m

2) Approach Bridges

The Study Team considered following three options:

- Extend the structural form of the main bridge;
- Use of simple supported or continuous precast post-tensioned concrete beams with a span of 30 - 50 meters; and
- Use of precast post-tensioned concrete beams with an in-situ deck section over the pier to form a continuous deck.

3) Dyke Bridges

The alignment across the Hanoi dyke at a skew of approximately 50° and requires a bridge to span a distance of approximately 130 meters, along the line of the alignment. The Study Team has adopted a span over the dyke of 130 meters with side spans of 90 meters.

The Gia Lam dyke spans a distance of approximately 90 meters, along the line of the alignment, between existing ground levels. The span of the bridge over the dyke is 105 meters with side spans of 70 meters.

For both of these locations the Study Team considered that the bridge type should be a prestressed concrete box girder constructed using temporary formwork to support the deck during construction.

(4) Study of Thanh Tri Bridge, Route Alternative-1

From the alignment survey the total distance between dyke embankments is measured at approximately 1.96 km with the normal water course situated close to the Hanoi dyke. The width of the normal water course is approximately 510 meters.

The height of the dyke embankments are:

Hanoi side : 14.45 meters
Gia Lam side : 13.50 meters

1) Main Bridge

Refer to paragraph 7.2. (3). 1).

2) Approach Bridges

Refer to paragraph 7.2. (3). 2).

3) Dyke Bridges

The Hanoi dyke is situated close to the normal water course and so has been incorporated into the main river crossing.

The Gia Lam dyke spans a distance of approximately 65 meters, along the line of the proposed alignment, between existing ground levels. The span of the bridge over the dyke is 65 meters with side spans of 45 meters. For this span arrangement the Study Team proposed to form the deck from a continuous prestressed concrete box girder constructed using temporary formwork to support the deck during construction.

8. SELECTION OF THE OPTIMUM ALTERNATIVE ROUTE

8.1 Selection Approach

The main focus of evaluation at this step is to select an optimum route among three route alternatives, the study flow is shown in Figure 8.1.

8.2 Selection of the Optimum Route

(1) General

Formation of a consensus amongst the Government agencies concerned the development policies of the SHTRR, in particular, to fix an optimum route prior to the start of preliminary engineering design, is indispensable.

(2) Evaluation of Route Alternatives

For the purpose of comparison of each alternative, the following criteria were taken into account:

- Land Availability
- Impact on the Social Environment
- Construction Economy
- Road user Benefits
- River Morphology

The comprehensive comparison and evaluation of each alternative are summarized in Table 8.1.

(3) Conclusion

It was concluded that Route Alternative-3 is recommended for the optimum route assuming that the SHTRR on the existing road at Yen So in Thanh Tri district will be constructed providing frontage roads.

Comparison of bridge types of Thanh Tri main bridge (PC continuous box girder bridge vs PC cable stayed bridge) is necessary evaluating the entire Project schemes.

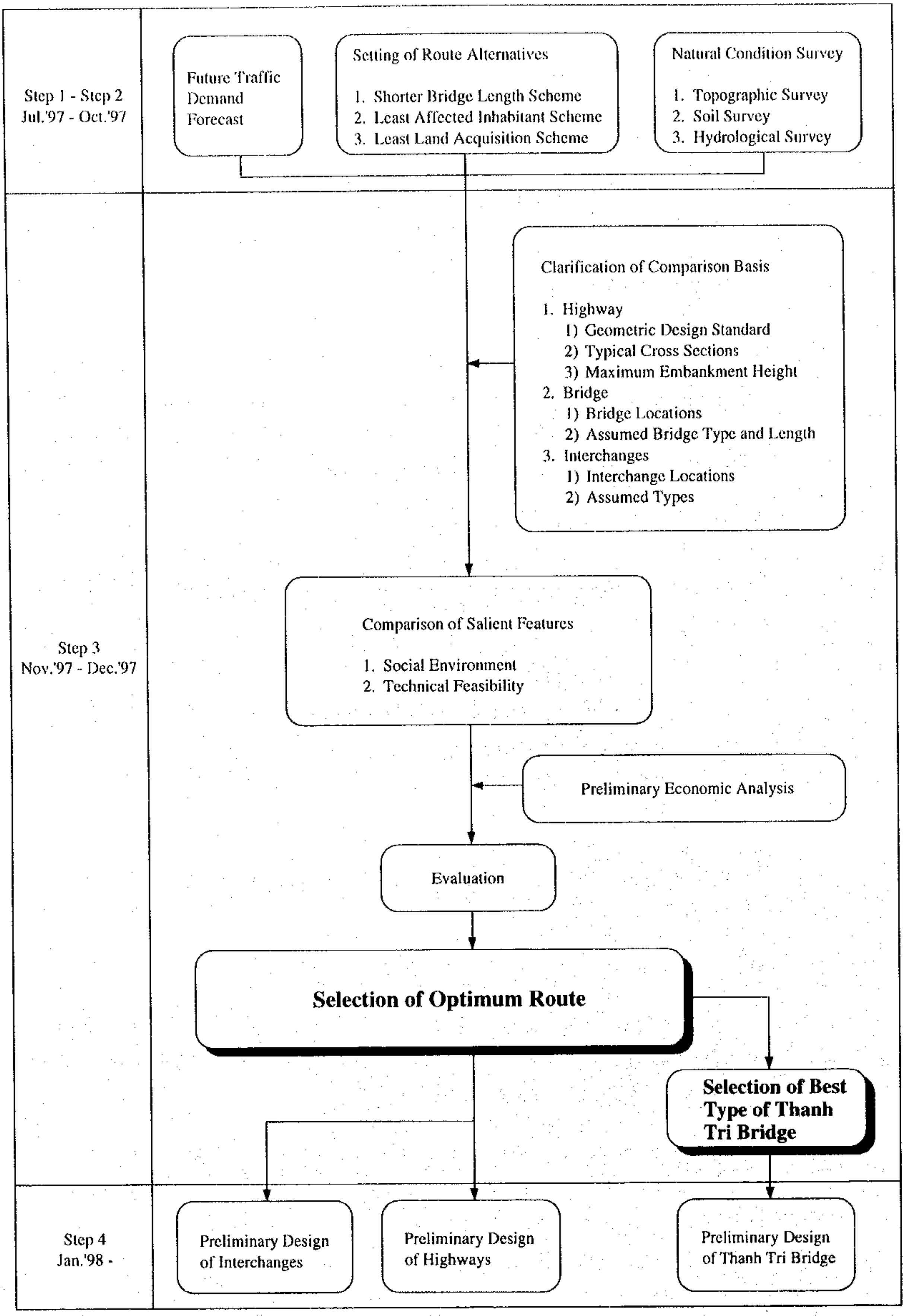


Figure 8.1 Study Flow for Selection of Optimum Route

Table 8.1 Comparison of Route Alternatives

Items		ALT-1:Shorter Bridge Length Scheme		ALT-2b:Least Affected Inhabitant Scheme		ALT-3:Least Land Acquisition Scheme
Major Indices						
Route Length		11.6 Km		12.05 Km		12.3 Km
Thanh Tri Bridge Length		1,860 m		2,340 m		2,340 m
Construction Cost Indices		0.95		1.01		1.00
Land Acquisition & Compensation						
Acquired Land Area		68.3 ha		70.7 ha		61.7 ha
Affected Houses		315		225		422
Affected Inhabitants		1,400		1,000		1,900
Evaluation						
Social Environment						
Land Availability	○	It is necessary to acquire 3.6 ha inhabited lands along NH-1, NH-5 and both dyke roads, and a pottery factory and a warehouse at Nam Du Ha will be affected. However, no protected or environmentally sensitive area is found because the route passes open spaces such as pond, arable land and undeveloped area.	○	It is necessary to acquire 3.0 ha inhabited lands along NH-1, NH-5, and a cement warehouse of Chinfon factory at Linh Nam will be affected. However, no protected or environmentally sensitive area is found because the route passes open spaces such as pond, arable land and undeveloped area. The route will manage to pass beside the Hero's cemetery of Linh Nam commune just in case of required ROW of 50 m wide.	○	It is necessary to acquire 9.6 ha inhabited lands along NH-1, NH-5 and 4 km long existing road at Yen So in Thanh Tri. However, since wide open space behind the existing road is available for relocation of affected inhabitants, 7.6 ha land acquisition itself has no difficulty in this stretch. A cement warehouse of Chinfon factory at Linh Nam will be affected, but the route in the remaining section passes open spaces such as pond, arable land and undeveloped area.
Impact on Social Environment	△	Since the route passes beside cemetery at Phap Van and Yen Duyen in Thanh Tri, some practical countermeasures against community severance are deemed necessary. Several tombs are required to be relocated at Tho Khoi in Gia Lam. 230 of 315 affected houses and several tombs are deemed necessary to be relocated elsewhere.	○	Since the route passes beside cemetery at Phap Van and Yen Duyen in Thanh Tri, some practical countermeasures against community severance are deemed necessary. 155 od 225 affected houses are deemed necessary to be relocated elsewhere.	○	Since the route passes build-up area at Yen So and Pagoda at Xa Tran Phu in Thanh Tri, some practical countermeasures against community severance are deemed necessary. 162 of 422 affected houses are deemed necessary to be relocated elsewhere.
Technical Feasibility						
Construction Economy	○	The length of route is the shortest, and Thanh Tri bridge becomes shorter as well. However, the route passes many water reservoirs and ponds where soft soil treatment is required in case of embankment. New NH-1 IC is located 1.25 km north from ALT-3 to increase relative cost on comparison basis. Construction cost is lower but higher maintenance cost and longer construction period are expected.	△	The route passes several water reservoirs and ponds where soft soil treatment is required. 1.25 km farther New NH-1 IC from ALT-3 and longer Thanh Tri bridge length than ALT-1 increase relative cost on comparison basis. Construction cost is higher and higher maintenance cost and longer construction period are expected.	○	Although the route is the longest and has longer Thanh Tri bridge length than ALT-1, relative cost on comparison basis is the same level of ALT-2b because of shorter length crossing over water reservoirs and ponds where soft soil treatment is required. Lower maintenance cost and shorter construction period are expected.
Road User's Benefits	○	The shorter scheme has advantages of considerable travel time and vehicle operating cost savings.	△	Sharper horizontal curve less 500m which has significant higher rate of traffic accident will be applied to avoid violation of inhabited area.	△	The longer route has disadvantages of travel time and vehicle operating cost for through-travelling users who will occupy half of total users in 2010.
River Morphology	△	Surveyed river cross sections imply slight presence of inbalanced scouring force at river bed rather than ALT-2b and 3.	○	Surveyed river cross sections ascertain balanced scouring force at both sides of river bed.	○	Surveyed river cross sections ascertain balanced scouring force at both sides of river bed.
Planning Consistency	△	The route should coordinate with the Hanoi Master Plan to find a way how to cross their Yen So regulating reservoirs planned in Thanh Tri area.	△	The route should coordinate with the Hanoi Master Plan to find a way how to cross their Yen So regulating reservoirs planned in Thanh Tri area.	○	This alternative has the same route as the city planning road shown in the Hanoi Master Plan.
Comprehensive Evaluation		This scheme has advantages in the aspects of construction cost and road user's benefits. However, it is inferior in the aspects of stability of river morphology, planning consistency and social environment, especially for relocation of inhabitants and tombs.		This scheme is superior in the aspect of social environment, especially smaller number of affected persons. However, it is inferior to horizontal alignment, construction economy and planning consistency.	◎	It apparently is bigger number of affected persons, but most of them are along existing road at Yen So, and they are easily set back in the same way as NH-5 widening. However, it has advantages of stability of river morphology, construction economy and planning consistency.

Notes:

○ Fair or Superior

△ Poor or Inferior

9. BRIDGE ALTERNATIVE STUDY AND SELECTION OF THE RECOMMENDED BRIDGE TYPE FOR THANH TRI BRIDGE

9.1 General

Alternative Study of Thanh Tri Bridge and selection of the optimum bridge type were carried out on the selected route of Alternative 3 (refer to 7.1 Study of Alternative Routes). The concept of various alternatives of Thanh Tri Bridge is shown in Figure 9.1.

9.2 Alternative Bridge Types of Main Bridge

(1) Alternative 1: PC Continuous Box Girder Bridge

1) Super Structure

The most economical center span length of 130 m was chosen and the span arrangement of 80 m + 4 @ 130 m + 80 m = 680 m adopted.

2) Piers

From the requirement of high degrees of rigidity (i.e. water depth, seismic coefficient and boat collision force) Hanoi bound and Gia Lam bound bridge deck supports (piers and foundations) were combined.

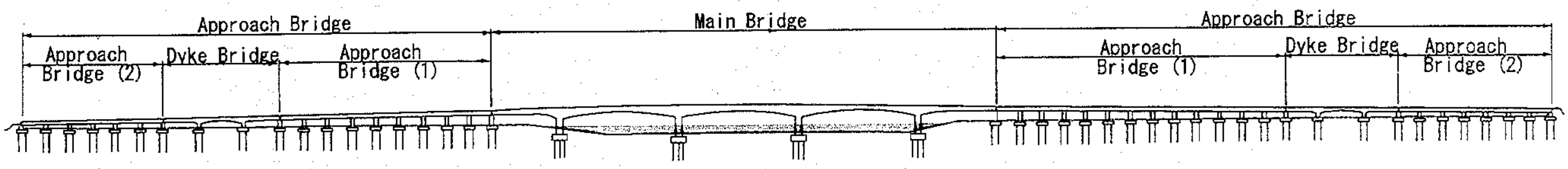
3) Foundation

Caissons and various design of foundation piling (i.e. steel pipe piles and cast-in-concrete piles) were compared and 2,000 mm diameter cast-in-situ concrete pipe piling was adopted.

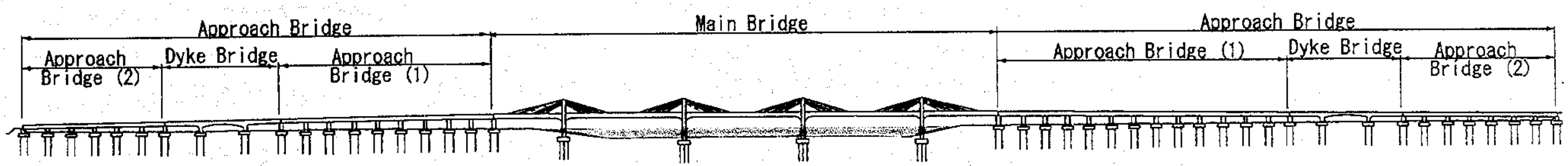
(2) Alternative 2 : PC Extradosed Bridge

Increasing the span of Bridge Alternative 1 to a span of 180 m (i.e. economic span) will necessitate a concrete box girder of 10.5 m in depth at piers. This depth of construction may cause construction difficulties in Vietnam and the Study Team proposed to use a hybrid concrete box girder (known as 'extradose' in Japan). This bridge type incorporates low level cable stays to increase the effective girder section at the piers. The adopted span arrangement is 100 m + 3 @ 180 m + 100 m = 740 m, with concrete towers of 20.0 m above the deck.

ALTERNATIVE 1: PC Continuous Box Girder Bridge



ALTERNATIVE 2: PC Extradosed Bridge



ALTERNATIVE 3: PC Cable Stayed Bridge

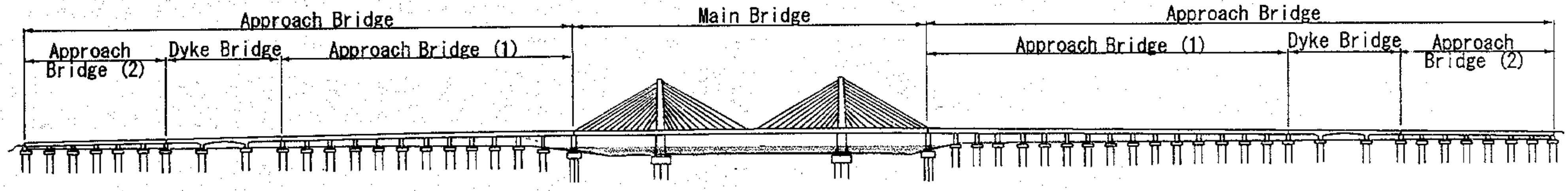


Figure 9.1 Concept of Alternatives of Thanh Tri Bridge

(3) Alternative 3 : PC Cable Stayed Bridge

1) Superstructure / Towers

The Study Team selected the most economical span arrangement of 130 m + 260 m + 130 m = 520 m. The height of tower is approximately 91 meters above sea level. the height of the towers are within the limits defined by the Vietnam Aviation Department.

2) Piers / Foundation

Refer to 9.2 (1) in above.

9.3 Determination of Bridge Types of Approach and Dyke Bridges

(1) Approach Bridges

The approach bridges have been grouped into the following types.

- Approach Bridge (1) : the bridge between the main river bridge and the dyke bridge;
- Approach Bridge (2) : the bridge between the dyke bridge and abutment.

1) Approach Bridge (1)

For the determination of the economical span arrangement, the comparison study was carried out and found that 50 m span continuous design is the most suitable. The shape of piers are similar to the main bridge, however Hanoi bound and Gia Lam bound are separated. Cast-in-situ concrete piling (D = 1,500 mm) has been adopted.

2) Approach Bridge (2)

The use of a precast beams, either simple supported or made continuous for the live load condition, with a span of 30 m was determined. The piers are with oblong shaped columns and other designs are similar to Approach Bridge (2).

3) Dyke Bridges

The span arrangement of dyke bridges are as follows :

- Hanoi side : 75 m + 130 m + 75 m = 280 m ; and
- Gia Lam side : 50 m + 80 m + 50 m = 180 m.

However, further study is required based on the topographical survey results to be conducted in the detailed design. Piers/foundations are similar to Approach Bridge (1).

9.4 Screening of Alternative Bridge Types of Main Bridge

(1) Alternatives

The technical study and preliminary cost estimation were conducted on the following bridge alternatives.

Main Bridge ;	Alternative 1	:	4 span PC Continuous Box Girder Bridge, center spans = 130 m
	Alternative 2	:	3 span PC Extradosed Bridge, center spans = 180 m
	Alternative 3	:	PC Cable Stayed Bridge, central span = 260 m

Adopted designs for approach bridge and dyke bridges are identical for all alternatives:

Approach Bridge (1) ; PC Simple or Continuous Box Girder Bridge, span 50 m
Approach Bridge (2) ; PC T-Beam Bridge, span 30 m

Dyke Bridge ;	Hanoi Side	;	3 span PC Continuous Girder Bridge span 75 m + 130 m + 75 m = 280 m
	Gia Lam side	;	3 span PC Continuous Girder Bridge span 50 m + 80 m + 50 m = 180 m

(2) Elimination of Alternative 2

It is noted that Alternative 2: PC Extradosed Bridge has been eliminated from the available options in accordance with the decision of the Government's Steering Committee.

9.5 Evaluation of PC Box Girder Bridge and Cable Stayed Bridge Project Schemes based on Economic Study

The study of bridge types of Thanh Tri main bridge, PC continuous box girder bridge and PC cable stayed bridge, has been conducted based on full scale economic analysis. The study results are shown in Table 9.1.

Table 9.1 Summary of Economic Analysis

Unit of Cost: million Dong

Description	Box Girder Main Bridge Scheme	Cable Stayed Main Bridge Scheme
(1) Construction Cost of Highway and Interchanges 1)	1,390,860	1,390,860
(2) Construction Cost of Thanh Tri Bridge 2)	2,660,900	3,251,600
(3) Land Acquisition and Resettlement	129,654	129,654
(4) Engineering and Supervision (7 %)	283,623	324,972
Total Financial Cost	4,465,037	5,097,086
Total Economic Cost	3,984,452	4,546,512
Economic Internal Rate of Return	12.55 %	11.34 %
Benefit Cost Ratio (discounted at 12 % per year)	1.06	0.93

Notes: 1) Packages 2 and 3
2) Package 1
3) All costs include 10 % of physical contingency

The result of the economic analysis revealed that: the Project with box girder main bridge design is judged to be feasible, showing 12.55 % of internal rate of return which is higher than the opportunity cost of capital in Vietnam.

9.6 Comparison of Short-Listed Bridge Types (PC Continuous Box Girder Bridge and PC Cable Stayed Bridge)

(1) Bridge Type Selection Method and Scoring System

Bridge type selection method followed Japanese government standard. The scoring (weighting) system is shown in Table 9.2.

Table 9.2 Scoring System in Comparison Component Evaluation

Component of Evaluation	Scoring	
	Japanese Standard	Adopted Full Score
1. Construction Cost	40 – 50	50
2. Structural Characteristics	5 – 15	10
3. Constructability	5 – 15	15
4. Aesthetics	5 – 15	15
5. Maintenance	5 – 15	10
Total	-	100

(2) Scoring Method

1) Construction Cost

Superior alternative: Give full score

Inferior alternative: full score - $\left\{ \frac{\text{Construction Cost of Inferior Alternative}}{\text{Construction Cost of Superior Alternative}} - 1 \right\} \times 50$

2) Other Components

Good: give full score

Fair: 50 % of full score

Poor: put 0

(3) Evaluation Result

The summary of evaluation result of comparison component is shown in Table 9.3.

Table 9.3 Summary of Evaluation Result

Component of Evaluation	Gained Score			
	Alternative 1 PC Continuous Box Girder Bridge		Alternative 3 PC Cable Stayed Bridge	
1. Construction Cost	US$ 60 million	50	US$ 102 million	15
2. Structural Characteristics	Good	10	Fair	5
3. Constructability	Good	15	Good	15
4. Aesthetics	Fair	8	Good	15
5. Maintenance	Good	10	Good	10
Total Score	93		60	
Recommended Priority	1		2	

10. PRELIMINARY ENGINEERING DESIGN OF HIGHWAY

10.1 Design Policies

Basic design policies to be applied to the SHTRR were established after detailed study of surrounding conditions. Horizontal and vertical alignment designs were achieved by carrying out integral studies on geometric, structural, hydrological/drainage and geological aspects and by maintaining close contact and cooperation with the concerned people's committees and other authorities.

The outline of design policies and controls for the determination of horizontal and vertical alignment are described as follows:

- Safe and efficient movement of high volumes of traffic at the specified design speed (i.e., 100 km/hr) shall be attained by the provision of good roadway alignment;
- Where vertical and horizontal curves occur in combination or in close proximity to each other, consideration should be given to designing a flowing alignment by providing good coordination of these curves;
- Severance of local communities shall be avoided by the provision of flyovers and box culvert;
- Existing pump station, schools, monument, pagoda, church, cemetery and densely inhabited areas shall be avoided;
- Countermeasures shall be provided to maintain the functions of the existing roads, railways, waterways and irrigation channels which will be crossed by the SHTRR; and
- The embankment height shall be kept as low as possible to reduce foundation treatment effort as well as to shorten the construction period.

10.2 Traffic Capacity and Required Number of Lanes

(1) Methodology

The concept and methodology used for the highway capacity analysis were based on the "Highway Capacity Manual of Highway Research Board, U. S. A.". However, some adjustment was made to reflect local conditions based on the results of studies undertaken by the "Highway Research Board, Japan (Japanese Standard)", since much resemblance is found in type and size of vehicles and in operating conditions, in Vietnam and Japan.

(2) Summary of Traffic Capacity Analysis

Table 10.1 shows summary of traffic capacity analysis with brief notes in each calculation steps.

Table 10.1 Summary of Capacity Analysis

Description		Symbol	Unit	Adopted	Remarks
Highway Type		-	-	-	Urban Expressway
Landuse/Terrain		-	-	Urban/Flat	See Note below
Design Speed		-	km/hr	100	
Lane Width		-	m	3.75	
Lateral Clearance	Outer	-	m	3.00	
	Inner	-	m	1.00	
Basic Capacity		C_B	PCU/hr/lane	2,200	Multilane highway
Adjust-ment Factors	Lane Width	γ_L	-	1.00	
	Lateral Clearance	γ_C	-	1.00	
	Roadside Development	γ_I	-	1.00	
	Large Vehicles	γ_T	-	1.00	Trucks and buses
	Driver Population	γ_D	-	1.00	
	Planning Level-2	γ_P	-	0.85	0.90 in urban region (Japanese Standard)
Possible Capacity		C_L	PCU/hr/lane	2,200	$C_L = C_B \bullet \gamma_L \bullet \gamma_C \bullet \gamma_I \bullet \gamma_T \bullet \gamma_D$
Design Capacity per Hour		C_D	PCU/hr/lane	1,870	$C_D = C_L \bullet \gamma_P$
K-Factor		K	%	9	Highway Capacity Manual
D-Factor		D	%	55	Highway Capacity Manual
Design Average Annual Daily Traffic Volume		D_{AADT}	PCU/day/lane	18,900	Design AADT $= C_D \bullet \frac{5.000}{K \bullet D}$

(3) Conclusions

1) SHTRR

The number of lanes of the through traveled way is recommended to be a total of 4-lane for the both of Thanh Tri and Gia Lam sections of SHTRR (i.e., Total Capacity of 4-Lane Through Traveled Way = 18,900 x 4 = 75,600 PCU/day). The capacity contains certain allowance compared with the maximum daily traffic volume in 2010 (73,200 PCU/day).

2) Thanh Tri Bridge

The number of lanes of the through traveled way is recommended to be basically a total of six (6) lanes (motorcycle lanes separated in initial stage) for Thanh Tri Bridge (i.e., Total Capacity of 6-Lane Bridge = 18,900 x 6 = 113,400 PCU/day). The capacity has slight allowance even if compared with daily traffic volume in 2020 (111,700 PCU/day).

10.3 Cross Section Design

Elements of recommended typical cross sections of the SHTRR are noted below:

- Number of through traveled way lanes : 4-lane
- Lane width : 3.75 m
- Widths of shoulders : 3.0 m for outer and 1.0 m for inner
- Median : 2.0 m raised median width
- Side slopes : 1 on 2
- Frontage road : 2-lane, 8 m total width
- Bicycle path width : 3.0 m
- Sidewalk width : 3.0 m

Right-of-way widths of SHTRR are as follows:

- 50 m for the section of through traveled way with buffer zones;
- 60 m for the section of through traveled way with frontage road and border on one side ; and
- 70 m for the section of through traveled way with frontage road and border on both sides.

The Project covers not only the construction of through traveled ways of SHTRR but also the new construction of frontage road and borders. These are provided on one side or both sides of the through traveled ways in the selected SHTRR stretches. Table 10.2 shows the summary of cross section design of SHTRR.

Table 10.2 Summary of Cross Section Design of SHTRR

Station	Location	North side Frontage Road and Border (m)	Through Travelled Way Width (m)	South side Frontage Road and Border (m)	Typical Cross Section
1 + 000	NH No.1				
		14	2 x 11.5	14	Type D
4 + 500	Local Road Crossing				
		14	2 x 11.5	-	Type C
5 + 500	Local Road Crossing				
		14	2 x 11.5	14	Type D
6 + 000	Local Road Crossing				
		14	2 x 11.5	-	Type C
7 + 100	End of Thanh Tri Bridge				
		-	2 x 15.0	-	Type A
10 + 200	End of Thanh Tri Bridge				
		14	2 x 11.5	-	Type C
11 + 450	Local Road Crossing				
		-	2 x 11.5	-	Type B
13 + 100	NH No.5				

10.4 Interchanges

Figure 10.1 shows the location of interchanges on the SHTRR. Half cloverleaf type NH-1 IC was planned in the vicinity of Linh Dam lake to connect with National Highway No. 1.

Y-type interchange was planned at the NH-1 IC located 3 km east of existing NH-1 IC, which connects new NH-1 and SHTRR.

At the intersections of the SHTRR with the dyke roads it was proposed that half diamond interchanges be constructed to allow access to and from Thanh Tri Bridge.

Half cloverleaf type NH-5 IC was planned at the terminal point of the SHTRR to connect with National Highway No. 5.

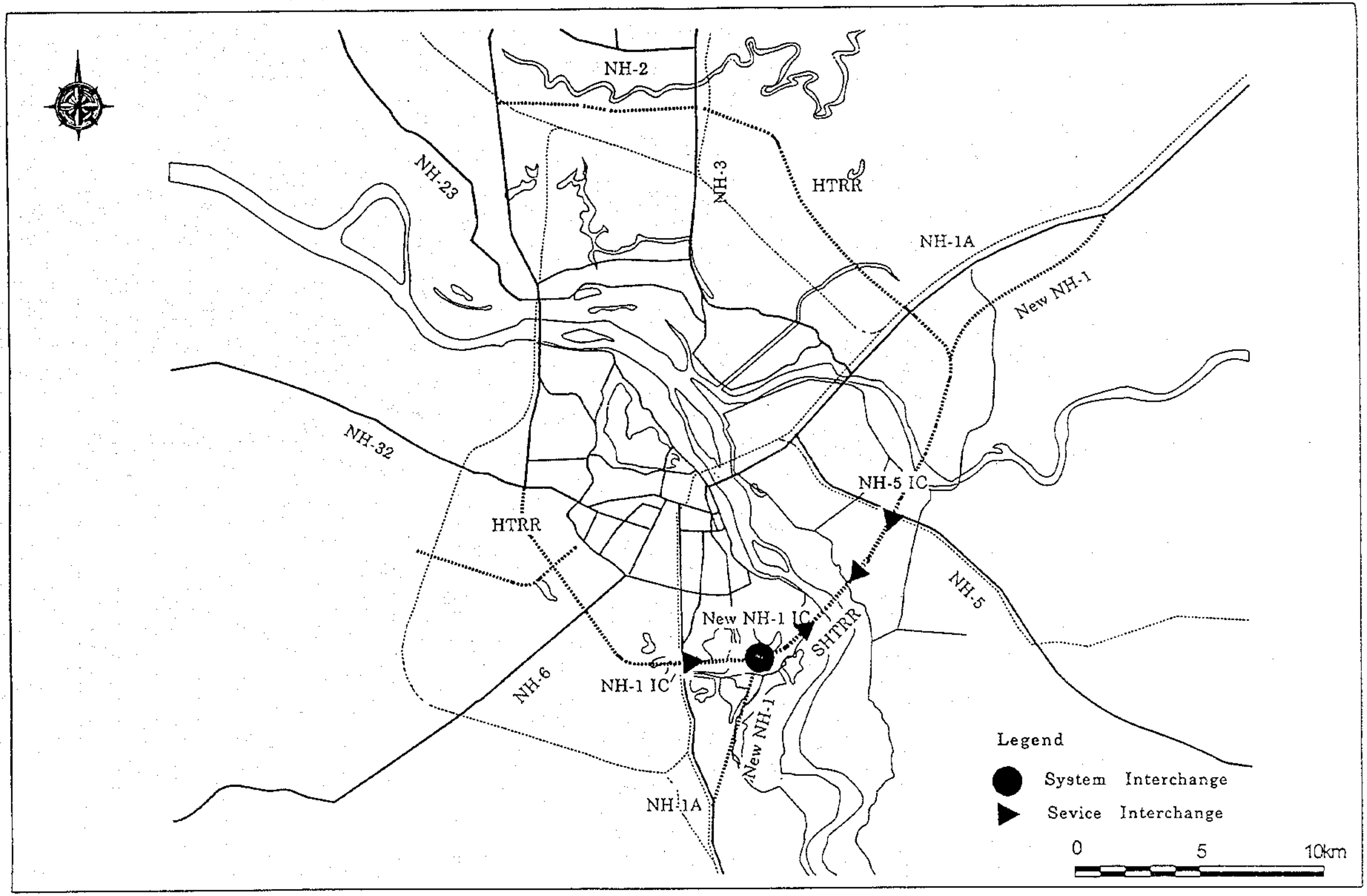


Figure 10.1 Location of Interchanges on the SHTRR

10.5 Summary of Geometric Design

The recommended design speed, typical cross sections and number of lanes for each package are shown in Table 10.3 and Figure 10.2.

Table 10.3 Design Speed, Number of Lane and Typical Cross Sections

Package	Length (km)	Design Speed	Number of Lanes	Typical Cross Section
Package 1: Thanh Tri Bridge	3.1	100 km/hr.	6	Type A
Package 2: Thanh Tri Section of SHTRR	6.1	100 km/hr.	4	Type C or D
Package 3: Gia Lam Section of SHTRR	3.2	100 km/hr.	4	Type B or C

10.6 Pavement Design

(1) Design Conditions

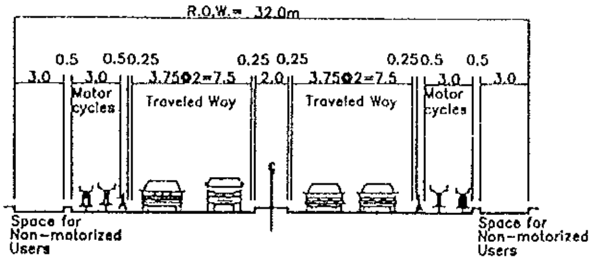
"AASHTO Guide for Design of Pavement Structures (1972 and 1986)" was used to determine the thickness of the pavement layers. The design condition is presented as follows:

- Pavement type : Flexible design
- Design life : 10 years
- Serviceability loss : 2.5
- Subgrade strength : CBR = 6

(2) Adopted Design Thickness

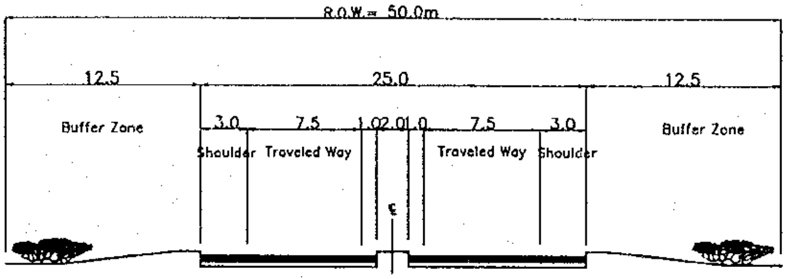
Pavement Component	Thickness (cm)
AC Surface	5
AC Binder	5
ATB	10
Stabilized Aggregate Base	15
Subbase	35
Total	70

Type A



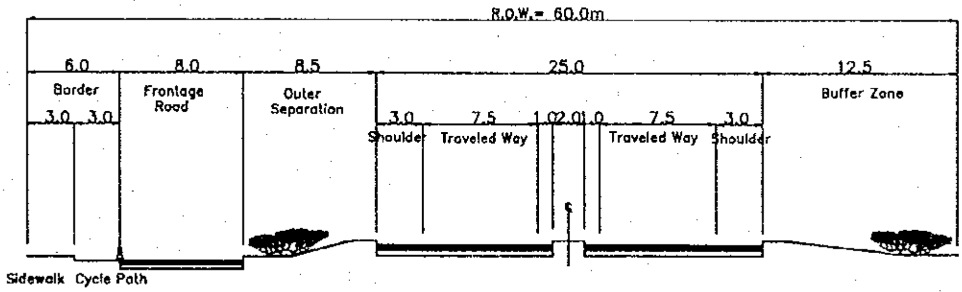
Motor Cycle Separation Scheme

Type B



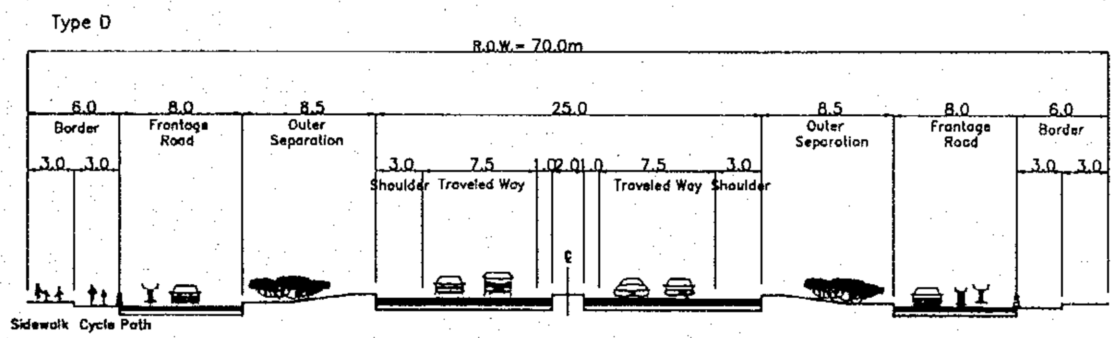
Through Traveled Ways with Buffer Zone

Type C



Through Traveled Ways with Frontage Road and Buffer Zone

Type D



Through Traveled Ways with Frontage Road on Both Sides

Figure 10.2 Typical Cross Sections

11. PRELIMINARY ENGINEERING DESIGN OF BRIDGES

11.1 Bridge Categories

The preliminary engineering design for the bridge structures has been divided into the following bridge categories:

- River Crossing (Thanh Tri Bridge);
- Interchange Structure;
- Flyover; and
- Drainage.

11.2 Thanh Tri Bridge

Thanh Tri Bridge is basically a river crossing bridge and was separated into:

- Main bridge which crosses water course of the Red River;
- Dyke bridge; and
- Approach bridges provided for both main and dyke bridges.

A continuous prestressed concrete box girder scheme was adopted for the main bridge. The design features of proposed bridges are shown in Table 11.1.

Table 11.1 Design Features of Thanh Tri Bridge

Category	Bridge Type	Span Arrangement/ Bridge Length (m)
Main Bridge	Continuous PC Box Girder	80+4@130+80 = 680
Approach Bridge (1)		
Thanh Tri Side	Continuous PC Box Girder	Bridge Length = 620
Gia Lam Side	Continuous PC Box Girder	Bridge Length = 780
Dyke Bridge		
Thanh Tri Side	Continuous PC Box Girder	75+130+75 = 280
Gia Lam Side	Continuous PC Box Girder	50+80+50 = 180
Approach Bridge (2)		
Thanh Tri Side	PC I or T-Girder	Bridge Length = 270
Gia Lam Side		Bridge Length = 300

(1) Main Bridge

The span arrangement of the main bridge is 80+4x130+80, an overall length of 680 meters, which gives sufficient clearance for the navigational requirements. To ease construction the design separates the cross section to form two individual and unconnected box sections, one for each carriageway.

The pier type for the Main Bridge was determined considering following matters:

- Piers are constructed in the normal water course of the river and the maximum depth of stream water will be up to 13 m in rainy season;

- Superstructure consists of PC continuous box girder (80m+4x130m+80m). This is a large superstructure which will result in big reactions. It is required for piers to have high rigidity and for the dimension of footing to be large. Therefore, the type of piers will be a combined structure supporting both for Hanoi- and Gia Lam-bound carriageways;

- Due to 32.8 m bridge width, the piers will require crosshead to support the bearings;

- The construction of piers in the river will disturb the water flow and will cause eddies on the down stream side and consequentially scour action will occur. To minimize scour action, the pier columns will be elliptical in shape;

- Ship/barge collision is on the design force of 125 tonnes. The protection system will be considered in the detailed design.

According to the soil investigation of Thanh Tri bridge area, the bearing stratum for foundation (N-value>50) appears on the elevation from -33 m to -43 m. Pile lengths shall be approximately L = 32 - 35 m for the Main Bridge. Cast-in-situ concrete pile ϕ2000 is selected as the most suitable foundation type.

(2) Approach Bridge (1)

Superstructure consists of PC continuous box girder (span 50 m). Comparing with Main Bridge the reactions are not as large so the scale of piers is not necessary to possess the high rigidity. Therefore, the substructure of Hanoi- and Gia Lam-bound carriageway shall be separated from the aesthetic viewpoint.

Piers near the normal water course of the Red River are submerged in the rainy season. The type of piers shall be elliptical in shape taking into consideration the main bridge pier type to allow compatibility from an aesthetic viewpoint.

Selection of foundation type was investigated as same procedure as main bridge, finally the cast-in-situ concrete pile ϕ1500 was selected both for Approach Bridges (1) and (2).

(3) Dyke Bridges

The span arrangements of dyke bridges are as follows in the preliminary design stage.

Thanh Tri side	75 m + 130 m + 75 m = 280 m
Gia Lam side	50 m + 80 m+ 50m = 180 m

However, further study is required based on the survey results that will be conducted in the detailed design stage.

Pier types were determined referring to the results of the main bridge study. Cast-in-situ concrete pile, ϕ1500 was selected according to the same reason of approach bridges.

(4) Approach Bridge (2)

Superstructure consists of PC simple girder bridge (span = 30 m). The reactions from superstructure are further reduced than Approach Bridge (1). Similar piers to those of Approach Bridge (1) were adopted.

Referring to the results of slope and ground stability analysis, the critical height of embankment is more than 10 m; however, it seems that the high embankment is not practical in the urban area, so the critical embankment height is within 6 - 7 m at abutments. The reversed T-type abutment was adopted in the design.

11.3 Flyover and Waterway Bridges

The cross section of the main carriageway bridge is shown in Figure 11.1 and the Study Team adopted precast beams to allow for future widening if required. For the type of piers, abutment and foundation refer to Approach Bridge-2.

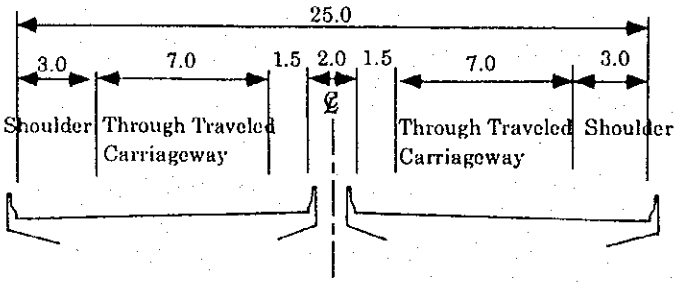


Figure 11.1 Typical Cross Section for Flyover and Waterway Bridges

11.4 Interchange Ramp Bridges

The horizontal curvature of the ramps (slip roads) requires a cross section to be able to resist both flexion and torsional moments. The optimum cross section will be either a steel or concrete box girder. However, the decision for the material choice will depend on the time of construction. A concrete solution would be the most economical, should the ramps be constructed at the same as SHTRR, where as a steel solution would result in less disruption if ramps be built in a later period. Concrete designs were adopted in the design.

12. CONSTRUCTION PLANNING

12.1 Construction Package and Scope

To consider a large scale construction, the entire construction is divided into 3 packages, they are:

Package 1: Thanh Tri Bridge;
Package 2: Thanh Tri Section of Southern Hanoi Third Ring Road; and
Package 3: Gia Lam Section of Southern Hanoi Third Ring Road.

(1) Package 1

Package 1 is the construction of 2 x 15 m effective width Thanh Tri bridge and comprises:

- Main bridge;
- Dyke bridge; and
- Approach bridges provided for both main and dyke bridges.

(2) Package 2

Main construction works in Package 2 is the construction of:

- Four lane throughways, frontage roads and border facilities;
- One partial cloverleaf type interchange to connect Southern Hanoi Ring Road (SHTRR) and National Highway No. 1 including flyover bridge;
- One Y-type interchange to connect SHTRR and New National Highway No. 1 including ramp bridges;
- One half-diamond type interchange to connect Thanh Tri bridge and dyke road; and
- Three prestressed concrete girder throughway bridges.

(3) Package 3

Main construction works in Package 3 is the construction of:

- Four lane throughways, frontage roads and border facilities;
- One partial cloverleaf type interchange to connect SHTRR and National Highway No. 5 including flyover bridge;

- One half-diamond type interchange to connect Thanh Tri bridge and dyke road;
- One barrier type toll plaza; and
- One prestressed concrete girder throughway bridges.

12.2 Hauling of Construction Materials

The construction involves the hauling of a large quantity of embankment, paving and concrete work materials. Basically the project area is provided with a sufficient road and inland water transport network. However, the pavement conditions of the existing local roads sometimes lack strength. Pavement strengthening/repair will be necessary but construction of new roads is unlikely.

In the roadway construction of Thanh Tri and Gia Lam sections, the construction should be executed in sequence in order to use the newly constructed road as a pilot so that it may be utilised in transportation of materials effectively. Existing dyke roads and local roads will be utilised systematically in order to expedite the construction work.

12.3 Source of Materials

(1) Borrow Materials for Embankment Construction

Table 5.2 in Section 5 shows the sources of embankment materials for the construction. The hauling distance (single trip) is generally less than 10 km at present however this distance may be increased in future due to the restriction of river sand exploitation since a large scale constructions such as NH No. 1 improvement will start shortly.

(2) Sources of Coarse Aggregates

The sources of Coarse Aggregates are shown in Table 5.3 in Section 5.

(3) Subbase and Base Coarse Materials

Subbase course materials from the existing rivers will require processing for gradation control, considering the nature of deposit.

A number of aggregate producers are in operation in the NH No. 1 corridor. Above mentioned Mieu Mon and Kien Khe quarries are presently producing crushed rock. The existing capacity of each quarry is 200 ton/hour and practically no limit in the limestone deposit.

(4) Asphaltic Concrete Mixtures

Producement of hot-mix asphaltic concrete is possible for the construction of asphalt treated base course and binder/surface course.

12.4 Construction Method of Thanh Tri Bridge

(1) Main Bridge

Cofferdams with steel sheet/pipe piling in the water will be required for the substructure construction. Cast-in-place concrete piling will be done using a reverse-circulation-drill method. The adoption of cantilever erection is required for the construction of continuous PC box girders.

(2) Dyke Bridges

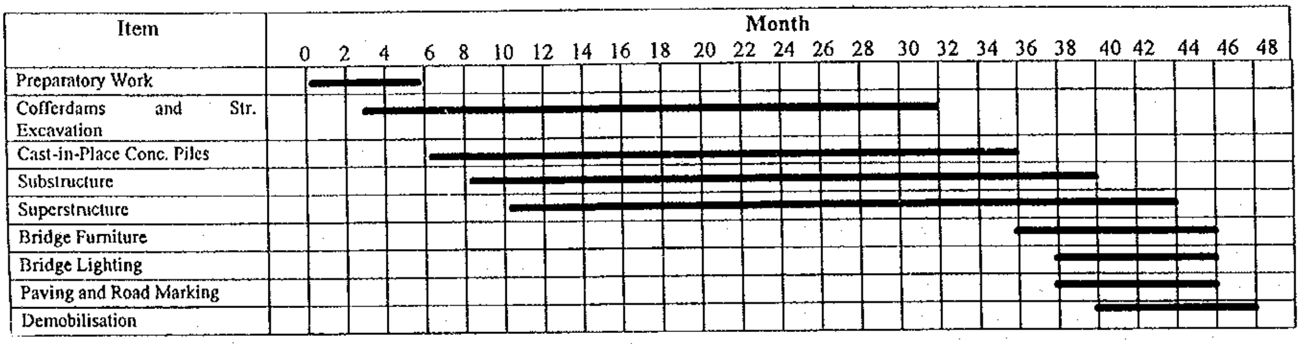
Piers of bridges must be located away from the dykes to avoid weakening of dyke embankment and foundation in accordance with the Government's requirement. This condition will also be applied during the pier construction.

(3) Approach Bridges

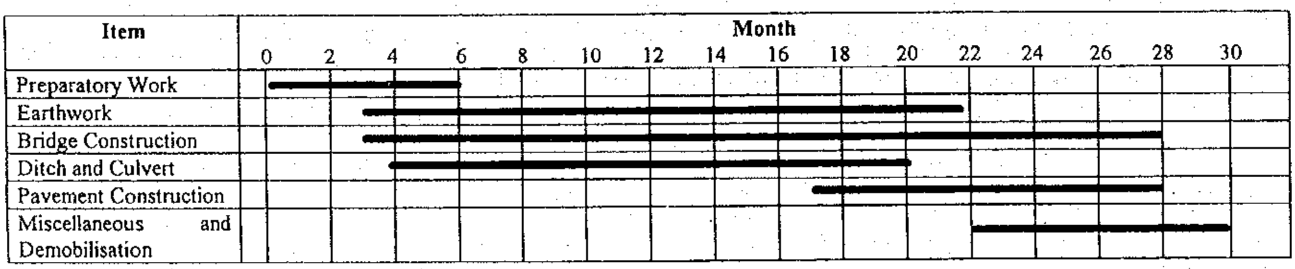
In general, post-tension or pre-tension method is applicable for the fabrication of PC box girder/PC T or I-beams. However, the latter method requires a large investment cost for the development of the plant and is not advantageous unless scale of construction scale is large. Also the latter method entails the difficulty of hauling of girders or beams if the road network lacks sufficient carriageway width and pavement strength for the passage of large trailer trucks.

12.5 Construction Time Schedule

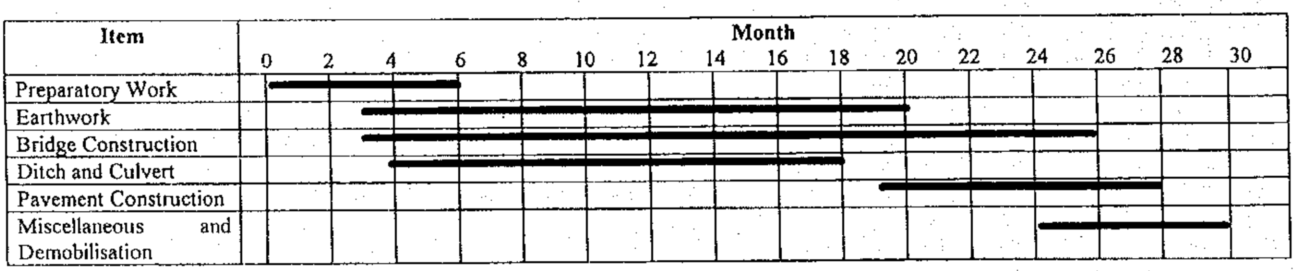
The construction time schedule for each construction package was prepared as shown in Figure 12.1.



Package 1: Thanh Tri Bridge



Package 2: Thanh Tri Section of SHTRR



Package 3: Gia Lam Section of SHTRR

Figure 12.1 Construction Time Schedule

13. MANAGEMENT AND MAINTENANCE

13.1 Present Situation of Highway Maintenance Management

(1) Organization of Ministry of Transport

Organization chart of the Ministry of Transport (MOT) is shown in Figure 13.1. As seen in the figure, MOT has five bureaus:

- Vietnam Road Administration;
- Vietnam National Railway;
- Vietnam River Administration;
- Vietnam National Maritime; and
- Vietnam Highway Standing Committee.

(2) Vietnam Road Administration Bureau

Road administration exists within the jurisdiction of MOT. Under the Government Decree No. 07, the Vietnam Road Administration Bureau (VRAB) was formed on 30 January 1993 and commenced operation on 26 May 1993.

The VRAB has three levels of administrative groups as shown in the following and the management is divided into 12 sections/offices:

- Management;
- Transport Companies; and
- Road Management Units.

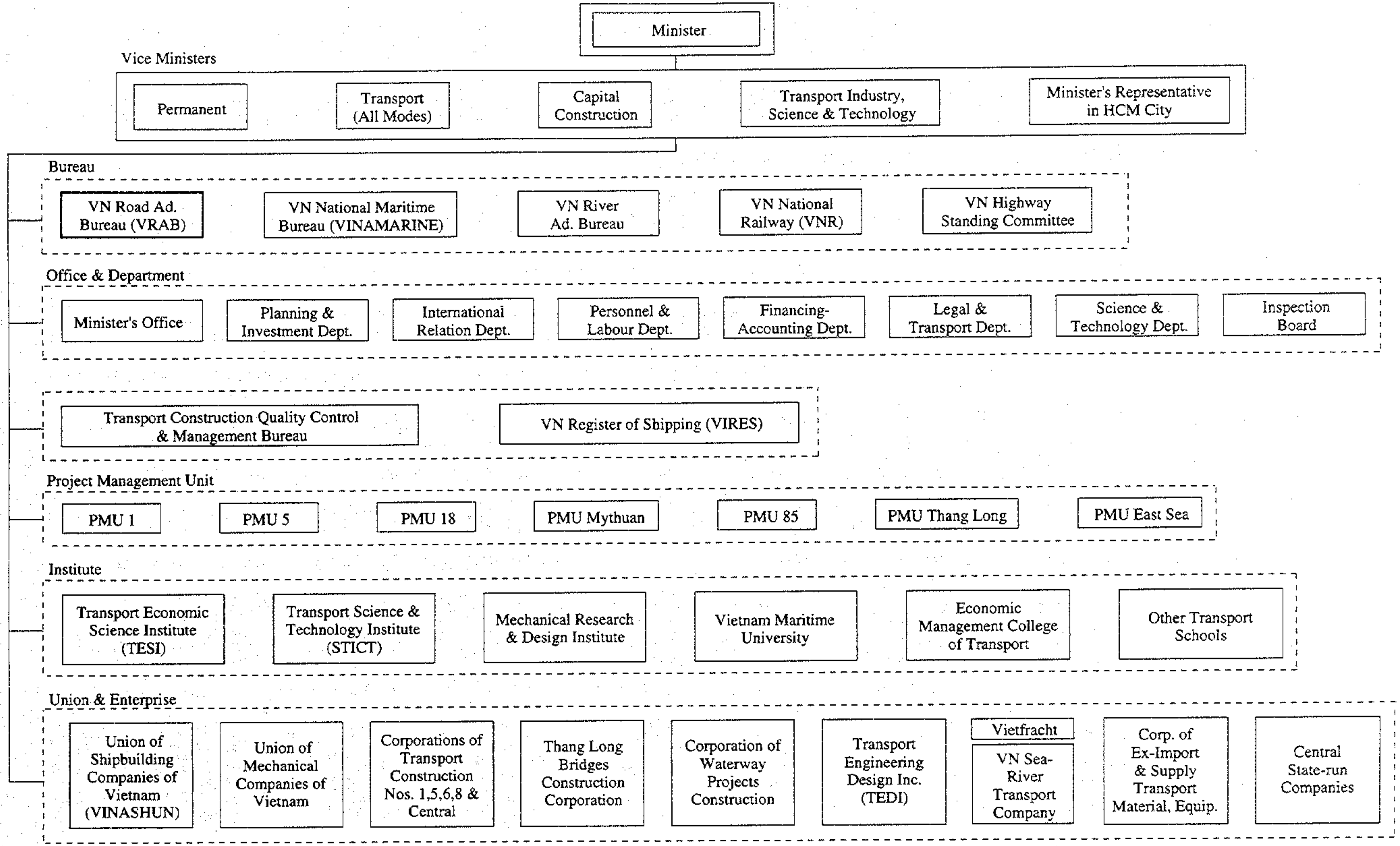
The comprehensive organization of the VRAB is shown in Figure 13.2 together with the number of employees for each group.

(3) Highway Maintenance Management

Regional Road Management Unit No. 2 (RRMU No. 2) is responsible for road management and maintenance of national highways in the northern part of Vietnam.

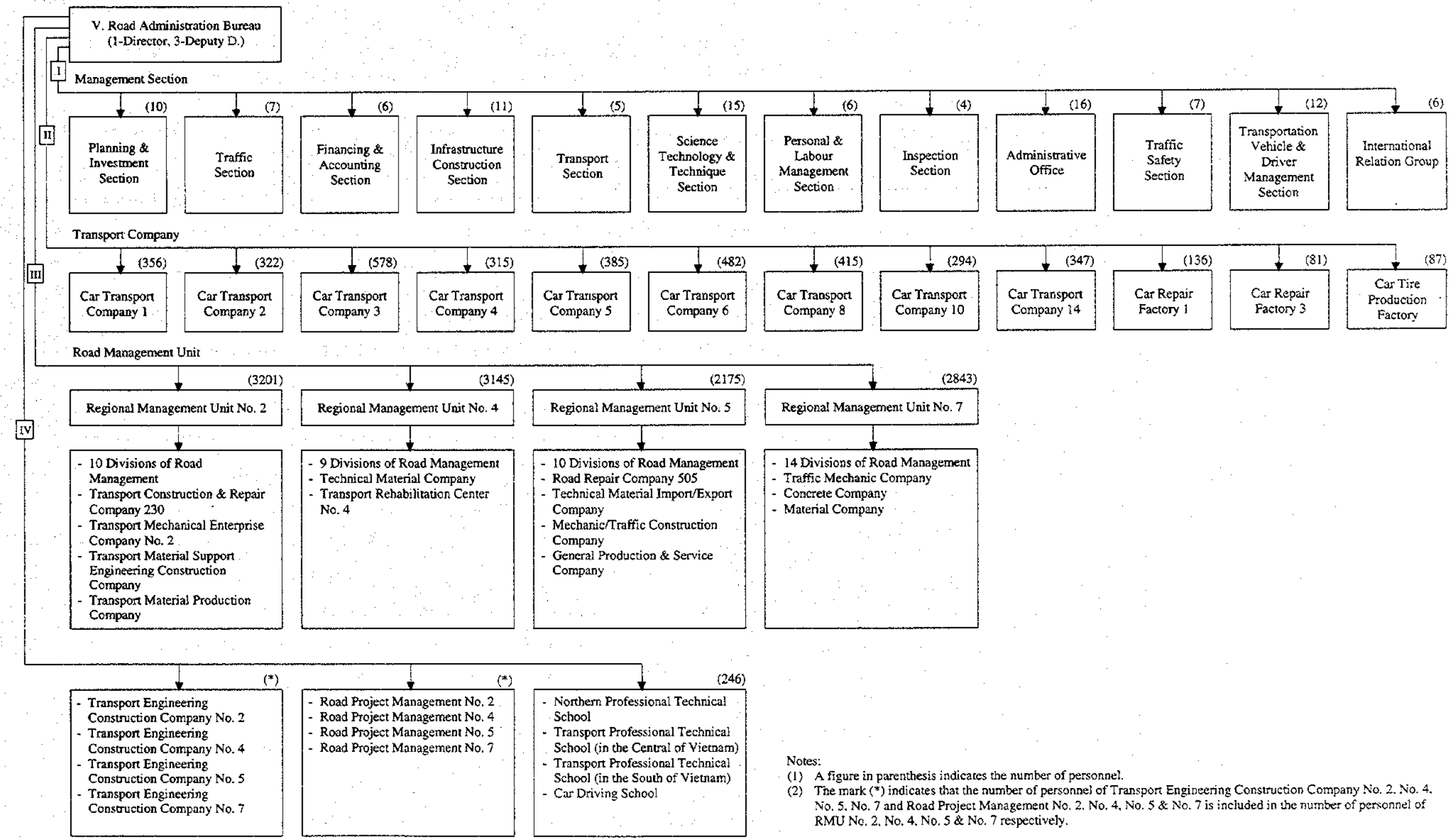
RRMU No. 2 is located in Hanoi and is mainly responsible for the maintenance of the National Highways Nos. 1, 2, 3, 4E, 5, 6, 15, 70, 183 and 279; a total of 1,476.5 km.

RRMU No. 2 is comprised of 10 Road Management Divisions and four autonomous enterprises. Road Management Divisions (RMD) are responsible for the routine maintenance of various lengths of national highway and receive an annual budget allocation from the MOT.



THANH TRI BRIDGE AND SOUTHERN SECTION OF HANOI THIRD RING ROAD

Figure 13.1 Organization Chart of Ministry of Transport



Notes:
(1) A figure in parenthesis indicates the number of personnel.
(2) The mark (*) indicates that the number of personnel of Transport Engineering Construction Company No. 2, No. 4, No. 5, No. 7 and Road Project Management No. 2, No. 4, No. 5 & No. 7 is included in the number of personnel of RMU No. 2, No. 4, No. 5 & No. 7 respectively.

THANH TRI BRIDGE AND SOUTHERN SECTION OF HANOI THIRD RING ROAD

Figure 13.2 Organization Chart of Vietnam Road Administration Bureau (VRAB)

The Management Division for Bridge and Ferry on the Red River has been included in the above 10 Road Management Divisions.

The function of RRMU No. 2 is divided into seven departments and an engineering center as shown in Table 13.1.

Table 13.1 Organization of RRMU No. 2 Head Office

Function	Organization Units	Staff	No. of Units
RRMU No. 2 Management Departments	1. Traffic Management Dept. 2. Planning Economic Dept. 3. Financial Accounting Dept. 4. Science and Technology Dept. 5. Personnel and Labor Dept. 6. Administrative Dept. 7. Traffic Safety Dept. 8. RMU No. 2 Engineering Center	70	8

The organizations of before-mentioned 10 Road Management Divisions (RMD) and four autonomous enterprises are shown in Table 13.2 together with numbers of staff for each organizational unit.

Only routine maintenance budget has been allocated to RMD and the other budgets for medium and large scale maintenance/repair has been allocated mostly to the Transport Construction and Repair Company. Allocated budget in 1994 and 1995 is shown in Table 13.3.

RMDs suffer from lack of maintenance equipment. In most cases, available equipment consists only one unit of grader, pick-up truck, and road roller.

Transport construction and repair company possesses the following vehicles and equipment for road maintenance and repair (Table 13.4).

Table 13.2 Organizations of 10 RMD and Four Repair/Production Units

Function	Organizational Units	Staff	Section	Team
Road Management Division (RMD)	1. Road Management Division (RMD) No. 222	241	4	7
	2. RMD No. 224	246	4	9
	3. RMD No. 226	257	4	5
	4. RMD No. 232	249	4	6
	5. RMD No. 234	387	4	4
	6. RMD No. 236	302	4	6
	7. RMD No. 238	137	4	5
	8. RMD No. 240	131	4	4
	9. RMD No. 242	300	4	5
	10. Management Division of Bridge and Ferry on the Red River	180	4	4
Repair Production Unit	1. Transport Construction and Repair Company 230	283	4	4
	2. Transport Mechanical Enterprise No. 2	122	3	3
	3. Transport Material Support Engineering Construction Company	213	3	3
	4. Transport Material Production Company	457	5	4

Table 13.3 Allocated Budget for Maintenance and Repair

Category of Maintenance/Repair	Allocated Budget (million Dong)	
	1994	1995
Routine Maintenance	12,886	16,136
Medium Scale Repair	23,712	24,484
Large Scale Repair	14,912	17,327

Notes
1) Routine Maintenance: Pavement potholes, drainage, signs, lane markings, weed
2) Medium Repair: Pavement overlay (2 cm - 4 cm), 163 km/year
3) Large Scale Repair: Pavement overlay (15 cm - 20 cm), 29 km/year

Table 13.4 Vehicles and Equipment Possessed by Transport Construction and Repair Company

Type of Equipment	Number of Unit
Concrete mixing plant	1
Truck, 10 tons	10
Steel wheel roller	1
Tire roller	1
Macadam roller	3
Passenger car	6

13.2 Management and Maintenance Plan

(1) System of Highway Maintenance

In order to attain proper highway management and maintenance, all systems of highway maintenance have to be carried out orderly and in a proper manner, and established organization must be consistent with the requirement of work components and needed capacities. Figure 13.3 shows the general flow chart of the recommended overall highway maintenance works.

(2) Maintenance Operating System

Highway Maintenance covers various activities related to inspections, maintenance and repairs, which require quick response and are appropriate to keep the highway open to traffic.

The following matters must be specified to implement the above operations:

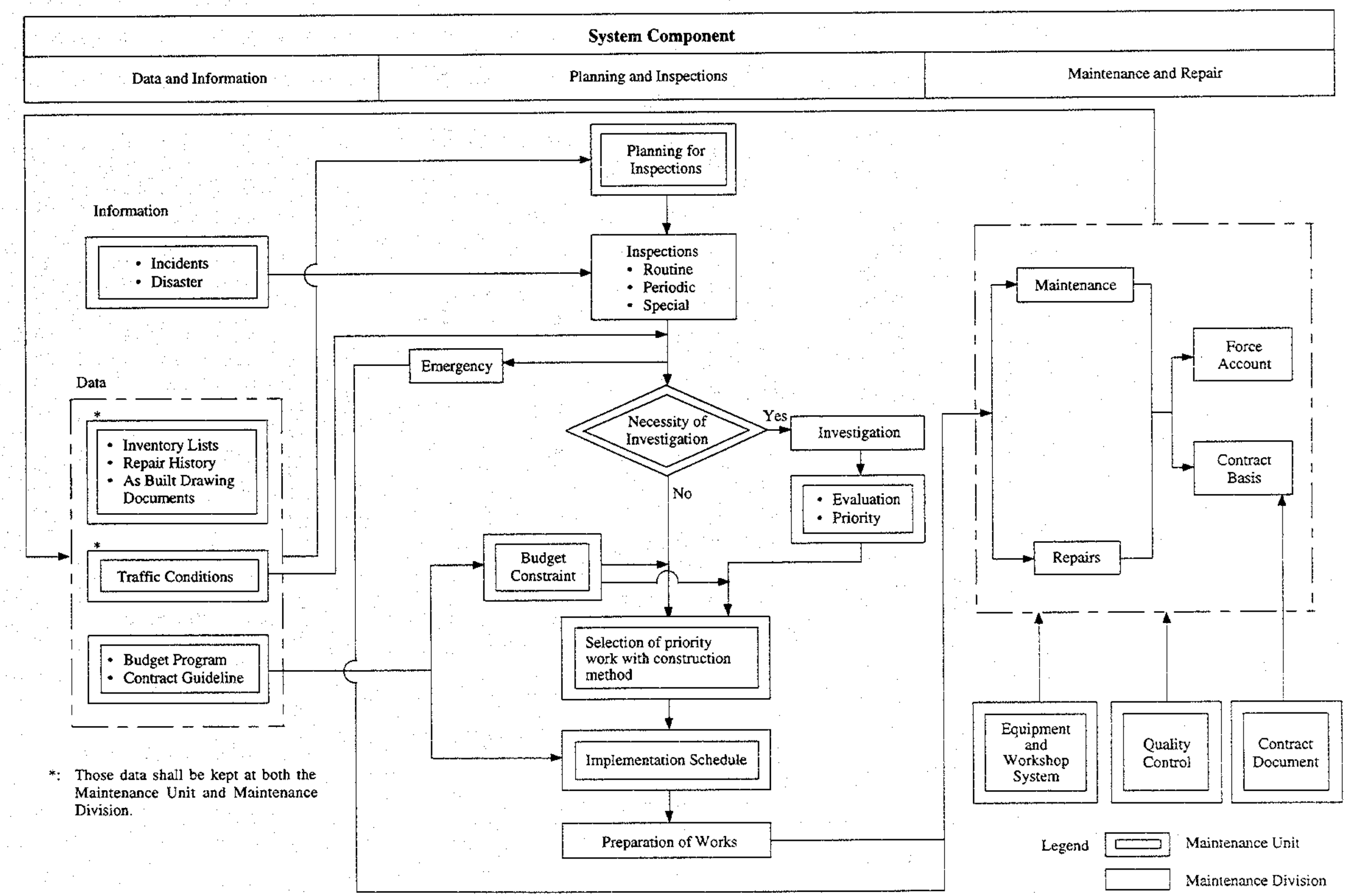
- Communications system (instruction, response, duty, decision and coordination) between headquarters of Maintenance Unit and Maintenance Division; and
- Extent of activities and responsibility of the Maintenance Unit and Maintenance Division.

The following should be considered to encourage the use of contractors to carry out highway maintenance activities:

- Maintenance activities based on a monthly and annual programme;
- Clarification of working criteria of maintenance and repairs;
- Formulation of contracts, supervision and acceptance system for highway maintenance work; and
- Provision of guidance to the contractors as to the significance of highway maintenance.

(3) Data Base and Management System

Data base and management system is indispensable for highway maintenance. One of the most important activities is to collect reliable data, in particular, to collect and keep as-built drawings and documents including design reports and specifications, construction record, and historical repair records.



*: Those data shall be kept at both the Maintenance Unit and Maintenance Division.

THANH TRI BRIDGE AND SOUTHERN SECTION OF HANOI THIRD RING ROAD

Figure 13.3 Flow Chart of Highway Maintenance Works

(4) Activities and Tasks of Highway Maintenance

The activities and tasks of the highway maintenance are shown in Figure 13.4.

(5) Safety Measures during the Highway Maintenance

Highway maintenance will be conducted, in careful consideration of traffic regulations, traffic safety and circumstances along the highway.

Personnel in charge of traffic control will be assigned during the maintenance and repairs. They will ensure smooth and safe traffic flow and worker's safety.

(6) Traffic Control Measures

The date, time-frame, construction methods and proposed traffic control measures will be analyzed for the highway maintenance activities based on traffic volumes, number of traffic lanes and detours.

13.3 Recommended Maintenance and Management Body

It is recommended that new Expressway Management and Maintenance Unit as well as Operation and Maintenance Division will be set up in the organization of Vietnam Road Administration Bureau to attain efficient management and maintenance of SHTRR and future Hanoi Third Ring Road.

It is also recommended that the force account activities of the Expressway operation and maintenance will be kept at minimum level in scope and volume and the major part of the works should be done by contract basis. However, Expressway Maintenance Unit must undertake information collection & dissemination, and maintenance activities requiring a quick response.

13.4 Recommended Operation and Maintenance Equipment

(1) Required Vehicles and Equipment

The Division will be equipped with the following limited kinds of equipment for operation and maintenance works under such a system.

- Communication cars, patrol cars and maintenance vehicles for expressway patrol, inspection and supervision of maintenance works being carried out by the contractors;

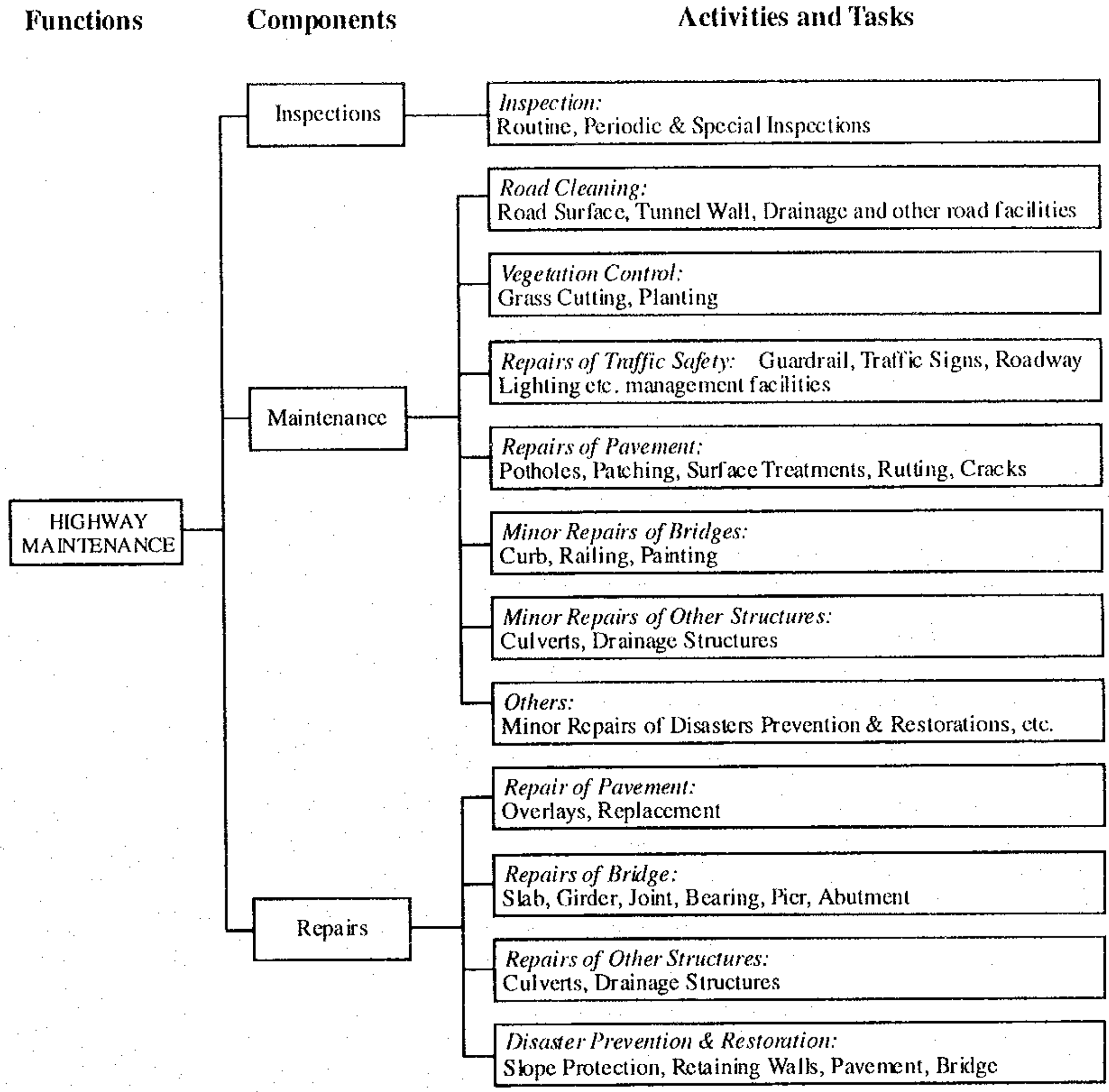


Figure 13.4 Activities and Tasks of Highway Maintenance

- Trucks, dump trucks, small crane vehicles, small rollers and tampers, air compressors, breakers, asphalt cutters, etc. for routine maintenance and emergency repair works on occasions of accident and disaster;
- Water tankers, grass cutters, etc.; and
- Ambulance vehicles.

(2) Workshop and Depots

Workshop and depot will be located near Operation and Maintenance Division (OMD) building. However, they might be of small scale since major maintenance and repair work will be done by contractors under the supervision of OMD.

14. PROJECT COST ESTIMATES

14.1 General

The estimate of the project cost was based on the results of preliminary engineering design, quantity take-off of each work item, and the studies on construction planning and method as described in the preceding chapters.

The basic premises in estimating the project cost are as follows:

- All the construction work will be executed by constructor(s) to be selected by international competitive bidding;
- The unit cost of each cost component was determined based on the economic conditions prevailing in January 1998 (USD $1.0 = 12,950 Dong);
- Engineering services cost is assumed to be 3 % of the construction cost;
- Supervisory services cost is assumed to be 4 % of construction cost; and
- Physical contingency is estimated to be 10 % of the total of construction cost, land acquisition and resettlement cost, engineering services cost and supervisory services cost.

The project cost was estimated in financial cost.

14.2 Construction Cost

(1) Unit Cost of Construction Works

The unit cost of construction works were studied based on the material cost, equipment cost, labor cost, overhead and profit for chief work items. The analyzed unit costs were compared with current bid prices and adjusted as required to obtain the most realistic prices.

(2) Estimated Construction Cost

The summary of estimated construction cost by each construction package is shown in Table 14.1.

Table 14.1 Summary of Estimated Construction Cost in 1998 Prices

Package No.	Construction Package	Foreign Exchange	Local Currency	Total
1	Thanh Tri Bridge	1,451,400	967,600	2,419,000
2	Thanh Tri Section of SHTRR	473,168	315,445	788,613
3	Gia Lam Section of SHTRR	285,483	190,322	475,805
	Total	2,210,051	1,473,367	3,683,418

Note: SHTRR denotes Southern Section of Hanoi Third Ring Road.

14.3 Land Acquisition and Resettlement Cost

Land acquisition and resettlement cost was estimated based on the area of required land acquisition estimated in the preliminary engineering design and the estimated building areas and number of resettled families in the field investigations.

The summary of estimated land acquisition and resettlement cost by each package is shown in Table 14.2.

Table 14.2 Summary of Estimated Land Acquisition and Resettlement Cost (Cost in Million Dong)

Package 1: Thanh Tri Bridge

Compensation Items		Costs (mill.VND)	Notes
Compensation Assets	1) Land compensation	-	
	4) Crops compensation	643	
Subsidy	7) Assistance for recovering	801	
Subtotal		1,444	
Administration costs		72	5% of the subtotal
Allowance		270	
Grand Total		**1,786**	

Package 2: Thanh Tri Section of SHTRR

Compensation Items		Costs (mill.VND)	Notes
Compensation	1) Land compensation	17,375	
	2) Houses compensation	34,065	Level II or III
	3) Other building compensation	7,859	
	4) Crops compensation	3,073	
	Subtotal	**62,372**	
Subsidy	5) Personal subsidy	2,160	
	6) Business or trade subsidy	198	
	7) Assistance for recovering	5,018	
	8) Assistance for moving	261	
	Subtotal	**7,637**	
Compensation and subsidy total		70,009	
Infrastructure cost for the resettlement sites		18,855	
Administration costs		3,500	5% of the compensation and subsidy costs
Allowance		10,263	
Total		**102,627**	

Package 3: Gia Lam Section of SHTRR

Compensation Items		Costs (mill.VND)	Notes
Compensation	1) Land compensation	3,515	
	2) Houses compensation	1,640	Level II or III
	3) Other building compensation	346	Graveyard included
	4) Crops compensation	1,660	
	Subtotal	7,161	
Subsidy	5) Personal subsidy	144	
	6) Business or trade subsidy	4	
	7) Assistance for recovering	2,975	
	8) Assistance for moving	20	
	Subtotal	3,143	
Compensation total		10,304	
Infrastructure cost for the resettlement sites		1,290	
Administration costs		515	5% of the compensation and subsidy costs
Allowance		1,345	10 % of the above
Grand Total		**13,454**	

Note: SHTRR denotes Southern Section of Hanoi Third Ring Road.

14.4 Estimated Project Cost

The estimated Project cost in 1998 prices is shown in Table 14.3 together with the shares of foreign currency and local currency portions. The Project cost is expressed in terms of financial cost.

Table 14.3 Summary of Project Costs of Foreign Exchange and Local Currency in 1998 Prices

Package 1: Thanh Tri Bridge

Unit: Million Dong

Description	Foreign Exchange	Local Currency	Total
(1) Construction	1,451,400	967,600	2,419,000
(2) Land Acquisition and Resettlement	0	1,786	1,786
(3) Engineering Services (3%)	50,799	21,771	72,570
(4) Supervision Services (7%)	118,531	50,799	169,330
(5) Physical Contingency (10%)	162,073	104,196	266,269
Total	1,782,803	1,146,152	2,928,955

Package 2: Thanh Tri Section of SHTRR

Unit: Million Dong

Description	Foreign Exchange	Local Currency	Total
(1) Construction	473,168	315,445	788,613
(2) Land Acquisition and Resettlement	0	102,627	102,627
(3) Engineering Services (3%)	16,561	7,097	23,658
(4) Supervision Services (7%)	38,642	16,561	55,203
(5) Physical Contingency (10%)	52,837	44,173	97,010
Total	581,208	485,903	1,067,111

Package 3: Gia Lam Section of SHTRR

Unit: Million Dong

Description	Foreign Exchange	Local Currency	Total
(1) Construction	285,483	190,322	475,805
(2) Land Acquisition and Resettlement	0	13,454	13,454
(3) Engineering Services (3%)	9,992	4,282	14,274
(4) Supervision Services (7%)	23,314	9,992	33,306
(5) Physical Contingency (10%)	31,879	21,805	53,684
Total	350,668	239,855	590,523

Note: SHTRR denotes Southern Section of Hanoi Third Ring Road

15. PROJECT IMPLEMENTATION PLAN

15.1 Execution of the Project

(1) Executing Agency

Project Management Unit Thang Long (PMU Thang Long), Ministry of Transport (MOT) is the Project executing agency and responsible for the execution of the following tasks:

- Pre-construction Works
  - Engineering Services (Review of Feasibility Study and Detailed Design); and
  - Land Acquisition and Resettlement.
- Construction Works and Construction Supervision

The necessary land acquisition and resettlement within proposed right-of-way will be undertaken prior to the start of the construction works. The organization chart of PMU Thang Long is shown in Figure 15.1.

(2) Procurement of Contractor(s)

Tender lot for the Project will be decided in consultation with the international financing agency. All times to be financed by the international financing agency shall be procured through international competitive bidding with pre-qualification in accordance with the guidelines of the international financing agency for procurement.

(3) Consulting Service for the Project

The selection and employment of the consultant for the consulting engineering (detailed design) and supervisory services shall be done in short-list method in accordance with the guidelines of the international financing agency.

(4) Budgetary Appropriation for the Project

Any portion of the Project not covered by the loan of the international financing agency are to be financed by the budget of the Government.

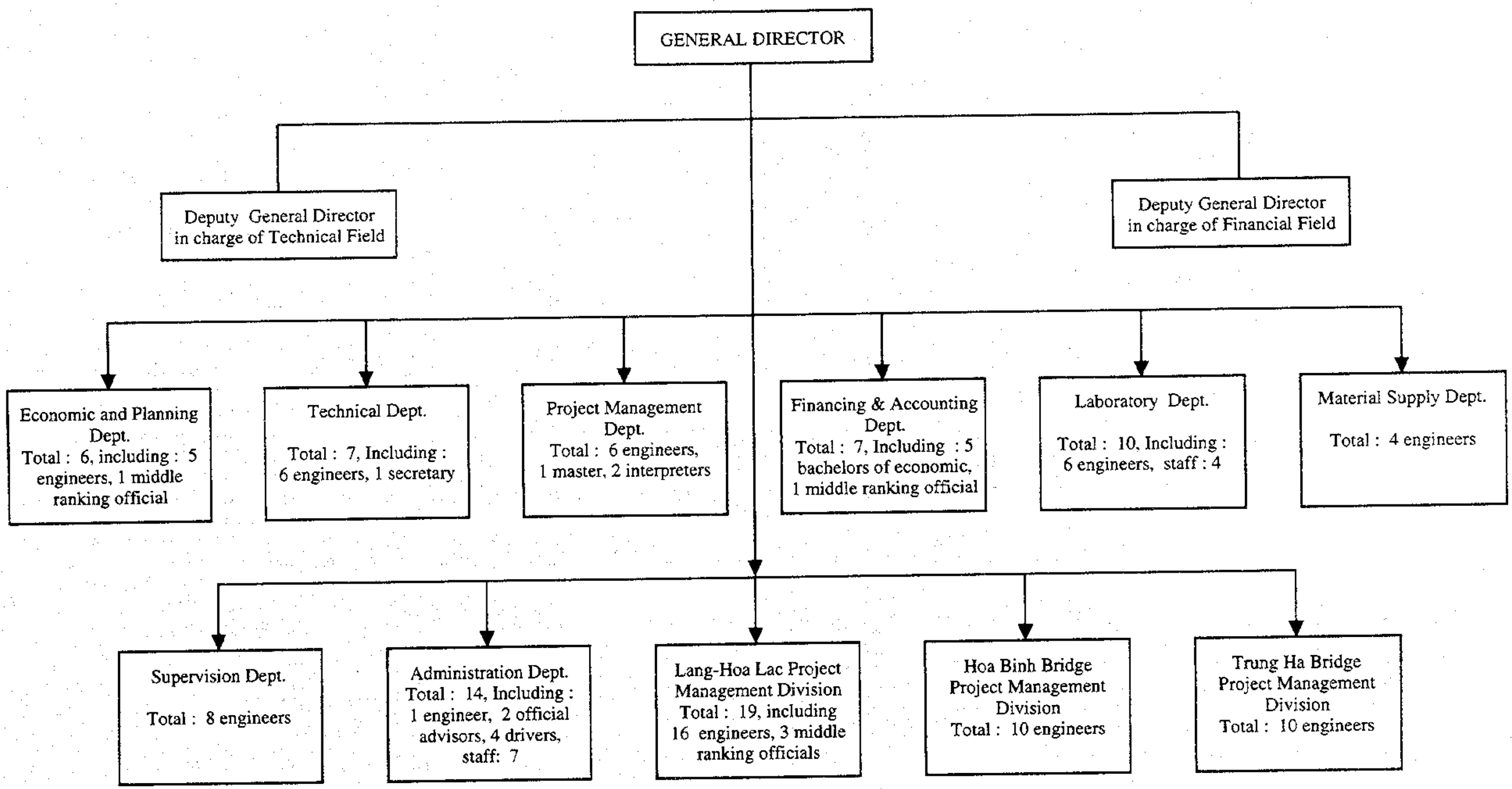


Figure 15.1 Organization Chart of PMU Thang Long

15.2 Project Implementation Time Schedule

(1) Construction Package

To consider a large scale construction, the entire construction is divided into 3 packages, they are:

- Package 1 : Thanh Tri Bridge;
- Package 2 : Thanh Tri Section of Southern Hanoi Third Ring Road; and
- Package 3 : Gia Lam Section of Southern Hanoi Third Ring Road.

(2) Construction Time Schedule

Construction time schedules were prepared based on the actual work quantities, site conditions and practical and economical construction methods. Taking into account the scale of the construction and the urgency of the Project, the maximum construction period were set:

- Package 1 : 4 years; and
- Package 2 and 3 : 2.5 years.

As shown in Figure 12.1 in Section 12, the completion of the construction in all packages will be set at the same time of 48th month to attain the optimum investment schedule.

(3) Project Implementation Time Schedule

Project implementation time schedule was tentatively drawn up as shown in Figure 15.2.

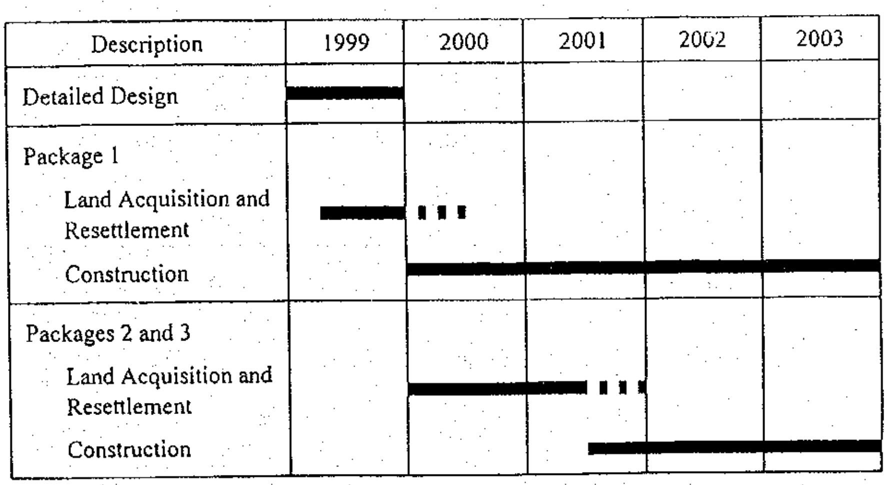


Figure 15.2 Project Implementation Time Schedule

15.3 Estimated Project Cost and Annual Fund Requirement

(1) Estimated Project Cost

The summary of project cost in 1998 prices is shown in Table 15.1. The project cost was expressed in term of financial cost by each construction package.

Table 15.1 Summary of Estimated Project Cost in 1998 Prices

Package No.	Construction Package	Project Cost (Million Dong)
1	Thanh Tri Bridge	2,928,955
2	Thanh Tri Section of SHTRR	1,067,111
3	Gia Lam Section of SHTRR	590,523
	Total	4,586,589

Note: SHTRR denotes Southern Section of Hanoi Third Ring Road.

(2) Estimated Annual Fund Requirement

A tentative disbursement schedule for the implementation of the Project was prepared as shown in Table 15.2.

Table 15.2 Estimated Annual Fund Requirement

Implementation	Year	Financial Cost (million Dong)
1st year	1999	123,517
2nd year	2000	361,329
3rd year	2001	1,054,047
4th year	2002	1,740,617
5th year	2003	1,307,079
Total		4,586,589

Note : Costs are in 1998 prices and no price contingency is included.

16. ECONOMIC AND FINANCIAL ANALYSIS

16.1 Economic Analysis

(1) Economic Cost

The investment cost of the Project was estimated at 4,586,589 million Dong:

a)	Highway and Interchange	1,390,860 million Dong
b)	Thanh Tri Bridge	2,660,900 million Dong
c)	Engineering and supervision	405,175 million Dong
d)	Land acquisition	129,654 million Dong
	Total	4,586,589 million Dong

Economic cost can be calculated by removing various distorted factors such as import/export taxes, regulation of minimum wage of unskilled labor, monopoly of land, foreign exchange rate fixed by the government, etc. Table 16.1 shows the conversion result from market price to economic price.

Table 16.1 Conversion to Economic Cost from Financial Cost

Unit: Million Dong

Items	Investment Costs In Market Prices	Foreign Portion	Local Portion					Overall Conversion Factor	Investment Costs in Economic Prices
			Tradable Goods	Non-tradable Goods	Skilled Labor	Unskilled Labor	Transfer (Tax)		
		1.004	1.004	0.996	0.985	0.300	0		
Hwy & Interchange	1,390,860	80 %	4 %	4 %	5 %	2 %	5 %	89 %	1,235,710
Thanh Tri Bridge	2,660,900	80 %	4 %	4 %	5 %	2 %	5 %	89 %	2,364,077
Engin.Supervision	405,175	80 %			15 %		5 %	90 %	365,042
Land Acquisition	129,654	0 %		100 %				100 %	129,135
Total	4,586,589								4,093,964
Routine Maintenance	27,520	0 %	2 %	3 %	0 %	90 %	5 %	27 %	7,429
Periodic Repair	4,587	0 %	5 %	3 %	2 %	80 %	5 %	29 %	1,329

Note: Routine maintenance cost is estimated at 0.6 % and Periodic maintenance cost at 0.1 % of the total investment cost.

Table 16.2 shows the construction period and cost allocation to 5 years.

Table 16.2 Yearly Allocation of Project Cost

Unit: Million Dong

Project Implementation	Implementation Year	Allocation Ratio	Financial Cost	Economic Cost
1st year	1999	3 %	123,517	110,251
2nd year	2000	8 %	361,329	322,520
3rd year	2001	23 %	1,054,047	940,837
4th year	2002	38 %	1,740,617	1,553,665
5th year	2003	28 %	1,307,079	1,166,691
Total		100 %	4,586,589	4,093,964

Note: Cost at 1998 Prices

(2) Benefit of the Project

Table 16.3 shows benefits by the realisation of the Project. In the city of Hanoi, average driving speed is less than 30 km/h at present. Main benefits by the construction of Thanh Tri bridge and SHTRR are; time cost saving of passenger and vehicles, and vehicle operating cost saving.

Table 16.3 Kinds of Benefit of the Project

(1) Benefits of Driving Time Saving (or Time Cost Saving)

(2) Benefits of Driving Cost Saving (or Vehicle Operating Cost Saving)

(3) Benefits from Increase of Land Productivity

(4) Other Benefits;

1) Decrease of Traffic Accident
2) Increase of comfortableness of traveling
3) Decrease of spoiling loss of agricultural products
4) Enhancement of Urban Development
5) Strengthening the Function as the Capital City
6) Decrease social cost by Improvement of Environments
7) Enhancement of Social Development
8) Integration of the Region

Figure 16.1 shows the method of measuring the value of saved time of passenger.

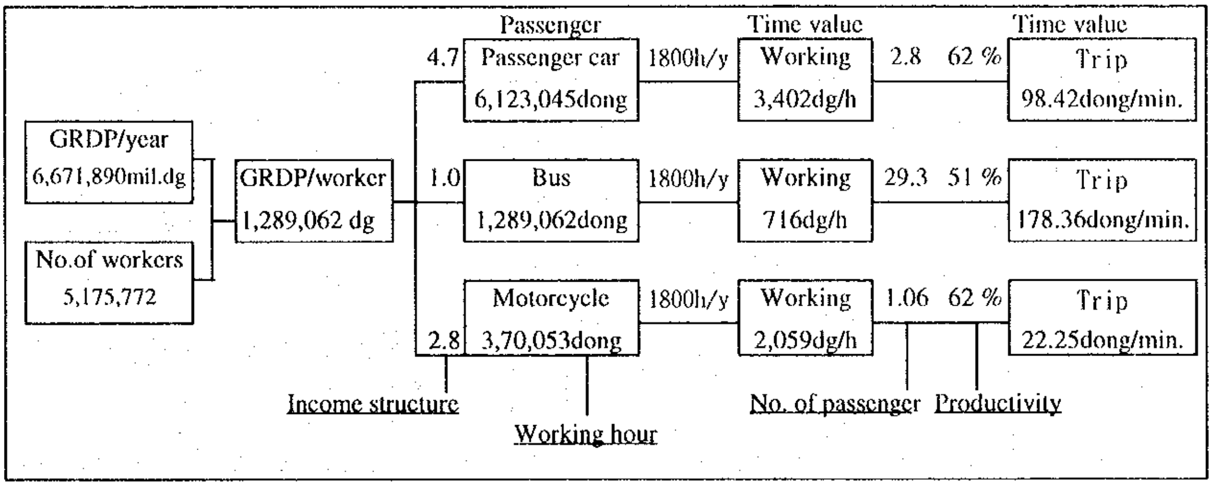


Figure 16.1 Transportation Time Value for Time Saving Benefit Calculation

Vehicle operation cost saving benefit is affected by many factors such as, vehicle type, running speed, road conditions, traffic conditions and others. Table 16.4 shows vehicle operating cost per vehicle-km. Seven vehicle types were classified into four types calculating from weighting average using composition ratio of vehicle types based upon the result of traffic count survey.

Table 16.4 Estimation of Economic Vehicle Operating Cost

Unit: Dong

Items	Passenger Car		Bus		Truck		M.Cycle
	Pas. Car	Van	Mid-Bus	L. Bus	M.Truck	H.Truck	M.Cycle
Running Costs/vehicle-km	1,656.51	1,137.08	1,369.21	3,544.46	2,006.43	2,781.66	280.38
Vehicle Component	0.84	0.16	0.67	0.33	0.89	0.11	1.00
Weighted	1,391.47	181.93	917.37	1,169.67	1,785.72	305.98	280.38
Running Costs/vehicle-km	1,573		2,087		2,091		280
Fixed Costs/Vehicle-km	392.60	410.34	626.00	1,471.70	954.15	1,356.38	41.14
Vehicle Component	0.84	0.16	0.67	0.33	0.89	0.11	1.00
Weighted	329.78	65.65	419.42	485.66	849.20	149.20	41.14
Fixed Costs/Vehicle-km	395		905		998		41
Grand total	1,968		2,992		3,090		321

Note: Base speed of passenger car and van are 45 km/h, and others 40 km/h

Driving speed will decrease year by year as traffic increases in the Study Area. Vehicle operating cost will increase, as vehicle speed decreases. Table 16.5 shows the set speed of vehicle by year and by vehicles.

Table 16.5 shows road users benefit of vehicle operating cost from shorter distance. Driving distance on street by vehicle type was estimated based on origin and destination survey. Road user can save average 6.5 km by using project road. V.O.C saving from higher design standards was estimated by the deference of driving speed between project road and ordinary street for 12.3 km.

Table 16.5 V.O.C Saving by Distance Reduction and Driving Speed Increase

Saving by Distance Reduction

Unit :Dong/Vehicle

Vehicle Type	Driving Distance by O.D (km)		Driving Distance (km)			V.O.C Saving	
			Street	Project	Saving	1998	2020
Passenger Car	25.8	24 %	18.37	12.3	6.07	17,751	20,623
Bus	27.3	26 %	19.44	12.3	7.14	22,751	24,700
Truck	28.6	27 %	20.37	12.3	8.07	33,477	36,953
Motor Cycle	23.9	23 %	17.02	12.3	4.72	1,685	1,808
Average	26.4	100 %	18.80	12.3	6.50	-	-

Saving by Driving Speed Increase

Unit :Dong/Vehicle

	Project Road	Street		V.O.C. Savings	
	2004-2020	1998	2020	1998	2020
Passenger Car	23,764	35,953	41,771	12,189	18,007
Bus	30,959	39,188	42,546	8,229	11,587
Truck	37,220	51,045	56,346	13,825	19,127
Motor Cycle	4,022	4,391	4,711	369	689

(3) Result of Economic Analysis

The internal rate of return is the discounted rate in which discounted present value of benefits equals to the total discounted present value of costs. The higher the economic internal rate of return, the higher the priority of the Project. At the same time, if the internal rate of return turns out higher than the opportunity cost of capitals, that is 12 %, investment is proved to be feasible.

The result of economic study revealed the following indicators:

(a) Benefit cost ratio discounted at 12 % 1.12

(b) Net present value discounted at 12 % 329,000 million dong

(c) Economic internal rate of return 13.14 %

This project is judged feasible, showing 13.14 % of EIRR, higher than the opportunity cost of capital in Vietnam.

16.2 Financial Analysis

(1) Toll Fee and Road Users' Benefit

Users' benefit of the Project consists of three items as shown in Table 16.6: i) time cost saving of passenger, ii) vehicle operating cost saving from distance reduction, and iii) vehicle operation cost saving from higher design standards.

Table 16.6 Road Users' Benefit by One Trip in the Year 1998 and 2020

Unit: Dong/vehicle

Vehicle Type	Time Saving Benefit		Vehicle Operating Cost Saving Benefit				Total Road Users' Benefit	
			Distance Saving		Design Difference			
	1998	2020	1998	2020	1998	2020	1998	2020
P. Car	2,579	4,387	17,751	20,623	12,189	18,007	32,519	43,017
Bus	6,128	9,364	22,751	24,700	8,229	11,587	37,108	45,651
Truck	0	0	33,477	36,953	13,825	19,127	47,302	56,080
M.Cycle	588	946	1,685	1,808	369	689	2,642	3,443

Level of toll fee must be less than users' benefit. Toll on the project road for 1998 was assumed to charge the same toll as Thang Long bridge since it is reasonable and realistic to charge of average toll of 45.2 % of users benefit.

Toll fee in future will increase as users' benefit increase in accordance with congestion increase in the city road. Therefore, following two cases of toll levels were used for estimation of revenue calculation as shown in Table 16.7.

Case 1: To keep the same toll/benefit ratio of present average 45.2 % (Thang Long bridge) till the year 2020

Case 2: To gradually increase toll/benefit ratio from 45.2 % in 1998 to 70 % in 2020

Table 16.7 Toll Fee Balanced with Road Users' Benefit and with Thang Long Bridge

Unit: Dong

Vehicle Type	1998			2020					
	Users' Benefit	Toll/B. Ratio	Thang Long Toll	Case 1			Case 2		
				Benefit	T/B. ratio	Toll	Benefit	T/B ratio	Toll
Passenger Car	32,519	36.9 %	12,000	43,017	36.9 %	15,874	43,017	70 %	30,112
Bus	37,108	57.9 %	21,480	45,651	57.9 %	26,426	45,651	70 %	31,956
Truck	47,302	48.3 %	22,840	56,080	48.3 %	27,079	56,080	70 %	39,256
Motor Cycle	2,642	37.8 %	1,000	3,443	37.8 %	1,308	3,443	70 %	2,410
Average	29,893	45.2 %	14,330	37,048	45.2 %	17,670	37,048	70 %	25,934

(2) Comparison between Toll Fee and Maintenance/Operation Cost

Table 16.8 is the result of comparison of routine/periodic maintenance cost of project road and operation cost for toll collection which is assumed at 20 % of toll revenue, with toll revenue from 2004 to 2028. Costs and revenue are compared by present value of 1998 price discounted by 15 %, average interest rate of market. Following revenue and cost ratio are obtained;

Case	Cost	Revenue	Revenue/Cost Ratio
Case 1	235 billion	779 billion	3.32
Case 2	290 billion	1,055 billion	3.64

Revenue of both case 1 and case 2 can cover the maintenance and operation cost, and gets more than 3 times revenue.

(3) Result of Financial Analysis

Viability of investment is proved by the comparison between toll revenue and expenditure using indicator of FIRR. The financial rate of return is the discount rate in which total discounted present value of toll revenue equals to the total discounted value of cost. If the FIRR turns out higher than the interest of market, investment is proved to be feasible.

The result of financial study revealed the following FIRRs:

		Case 1	Case 2
Government base	Soft loan 70 % and bank loan 30 %	2.83	5.64
Private base	Equity 30 % and bank loan 70 %	2.80	5.63

Table 16.8 Comparison between Maintenance/Operation Cost and Toll Revenue

Unit: Million Dong

	Year	Case 1 Cost Maintenance	Case 1 Cost Operation	Case 1 Cost Total	Case 1 Toll Revenue	Case 2 Cost Maintenance	Case 2 Cost Operation	Case 2 Cost Total	Case 2 Toll Revenue	Discount Factor 15%	Case 1 Present Worth Cost	Case 1 Present Worth Revenue	Case 2 Present Worth Cost	Case 2 Present Worth Revenue
1	1998									0.870				
2	1999									0.756				
3	2000									0.658				
4	2001									0.572				
5	2002									0.497				
6	2003									0.432				
7	2004	27,520	33,847	61,367	169,235	27,520	37,947	65,467	189,737	0.376	23,070	63,622	24,611	71,329
8	2005	27,520	36,589	64,108	182,944	27,520	41,819	69,339	209,097	0.327	20,957	59,805	22,667	68,354
9	2006	27,520	39,619	67,139	198,095	27,520	46,173	73,692	230,863	0.284	19,085	56,311	20,948	65,626
10	2007	27,520	42,976	70,496	214,882	27,520	51,082	78,602	255,412	0.247	17,426	53,116	19,429	63,134
11	2008	32,106	46,707	78,813	233,534	32,106	56,640	88,746	283,199	0.215	16,940	50,197	19,075	60,872
12	2009	27,520	50,864	78,383	254,318	27,520	62,953	90,473	314,766	0.187	14,650	47,534	16,910	58,832
13	2010	27,520	55,510	83,029	277,549	27,520	70,153	97,673	350,767	0.163	13,495	45,109	15,875	57,009
14	2011	27,520	58,275	85,795	291,377	27,520	75,193	102,712	375,964	0.141	12,125	41,180	14,516	53,134
15	2012	27,520	61,437	88,957	307,185	27,520	80,995	108,514	404,974	0.123	10,932	37,751	13,336	49,769
16	2013	32,106	65,049	97,155	325,246	32,106	87,697	119,803	438,483	0.107	10,382	34,757	12,803	46,858
17	2014	27,520	69,177	96,697	345,886	27,520	95,464	122,983	477,318	0.093	8,986	32,142	11,428	44,355
18	2015	27,520	73,897	101,417	369,485	27,520	104,495	132,015	522,477	0.081	8,195	29,856	10,667	42,219
19	2016	27,520	79,299	106,819	396,496	27,520	115,033	142,553	575,166	0.070	7,506	27,860	10,017	40,414
20	2017	27,520	85,490	113,009	427,448	27,520	127,368	154,888	636,842	0.061	6,905	26,117	9,464	38,911
21	2018	32,106	92,594	124,700	462,969	32,106	141,854	173,960	709,268	0.053	6,625	24,598	9,243	37,684
22	2019	27,520	100,759	128,279	503,797	27,520	158,916	186,435	794,579	0.046	5,927	23,276	8,613	36,710
23	2020	27,520	110,135	137,655	550,676	27,520	179,025	206,544	895,123	0.040	5,530	22,123	8,298	35,961
24	2021	27,520	111,384	138,904	556,922	27,520	185,102	212,621	925,508	0.035	4,853	19,456	7,428	32,332
25	2022	27,520	112,651	140,170	563,253	27,520	191,402	218,921	957,009	0.030	4,258	17,110	6,650	29,072
26	2023	32,106	113,934	146,041	569,672	32,106	197,934	230,040	989,670	0.026	3,858	15,048	6,077	26,142
27	2024	27,520	115,236	142,755	576,178	27,520	204,707	232,227	1,023,536	0.023	3,279	13,235	5,334	23,510
28	2025	27,520	116,555	144,074	582,774	27,520	211,731	239,250	1,058,654	0.020	2,878	11,640	4,779	21,145
29	2026	27,520	117,892	145,412	589,462	27,520	219,014	246,534	1,095,072	0.017	2,526	10,238	4,282	19,020
30	2027	27,520	119,249	146,768	596,243	27,520	226,568	254,088	1,132,842	0.015	2,217	9,005	3,838	17,109
31	2028	32,106	120,624	152,730	603,118	32,106	234,403	266,510	1,172,017	0.013	2,006	7,921	3,500	15,392
		710,921	2,029,749	2,740,670	10,148,744	710,921	3,203,669	3,914,590	16,018,343	15.00%	234,609	779,006	289,787	1,054,896

As Table 16.9 shows FIRR should be higher than 4.61 % in the case operated by the Government. It should be higher than 8.5 % in the case operated by private company, which includes 10 % of interest, around 2 % of dividend and 3 % of profit.

Table 16.9 Average Interest Rates for Cases Implemented by Private Sector and Government

Unit: Million Dong

Sources	Component	Amount	Interest Rate	Amount	Av. Interest Rate
1) Implementation by Government					
Soft Loan	70 %	3,210,612	2.3 %	73,844	
Bank Loan	30 %	1,375,977	10 %	137,598	
	100 %	4,586,589		211,442	4.61 %
2) Implementation by Private Sector			(Dividend+Profit)		
Equity	30 %	1,375,977	(2 %+3 %)	68,799	
Bank Loan	70 %	3,210,612	10 %	321,061	
	100 %	4,586,589		389,860	8.50 %

Financial viability can be concluded as follows:

i) Project Implementation by the Government

Case 1: FIRR of 2.83 % is lower than the average interest rate of 4.61 % and judged to be financially not feasible.

Case 2: FIRR shows 5.64 % which is higher than the average interest rate of 4.61 % and the Project is judged to be financially feasible.

ii) Project Implementation by Private Sector

Case 1 and 2: Calculated FIRRs are 2.80 % and 5.63 % for Case 1 and Case 2 respectively. These FIRRs are far lower than the average interest rate of 8.50 % and judged to be financially not feasible.

17. ENVIRONMENTAL IMPACT STUDY

17.1 Scope and Objectives of the Study

(1) Initial Environmental Examination

Initial Environmental Examination (IEE) was carried out along the following three alternative routes (refer to Section 7.1 Study of Alternative Routes).

Alternative-1	:	Shorter Bridge Length Scheme
Alternative-2b	:	Least Affected Inhabitant Scheme
Alternative-3	:	Least Land Acquisition Effort Scheme

The objective of the IEE is to identify the significant environmental factors along the above three alternative routes.

(2) Environmental Impact Assessment

Environmental Impact Assessment was carried out along the selected SHTRR (i.e. including Thanh Tri Bridge) route. The environmental investigation area covered 200m wide strips (i.e. area 100 m from planned highway centerline on both sides) along the SHTRR.

The objectives of the EIA are to analyze and forecast the impacts of the significant environmental elements and to consider the mitigation measures for the possible serious adverse impacts.

17.2 Study Method

The IEE was carried out based on the available data/information obtained by data collection from the relevant agencies and field observations. An overall evaluation (environmental screening and scoping) of possible environmental impacts which will be caused by the project activities was carried out based on a checklist method.

Further, based on the results of the IEE, environmental survey results and other available information, the existing environmental conditions in the selected route and the adjacent area were identified and the expected significant environmental impacts in the construction phase and operation/maintenance phase were analyzed. Finally, based on the above mentioned analyses, countermeasures to mitigate the possible serious adverse impacts caused by the Project were considered. The countermeasure study included the overall cost estimation for the execution of environmental countermeasures.

17.3 Environmental Evaluation

Based on the results of the IEE and EIA analyses, the environmental evaluation in the construction and operation/maintenance phase was carried out for the selected route as shown in Table 17.1.

17.4 Mitigation Measures of Adverse Environmental Impact

Although the engineering design and construction methods will also consider the mitigation measures for expected environmental adverse impacts, the following measures should be taken:

(1) Construction Phase

- Control of water pollution for toxic waste and acid sulphate or alkaline effluents;
- Implementation of water quality monitoring for the construction works;
- Erosion and sediment control such as re-vegetation for land disturbance areas;
- Control of air pollution such as sealing of local access road surfaces;
- Implementation of air quality monitoring for the construction vehicles;
- Control of construction noise and vibration especially at concrete bathching plant;
- Management of procurement/dumping of construction materials such as bridge foundation piles;
- Maintenance of temporary construction works; and
- Instruction of the workers concerning the importance of the cultural properties.

(2) Operation/Maintenance Phase

- Erosion control such as re-vegetation of the river banks;
- Control of water pollution for accidental spills into the rivers;
- Implementation of air quality monitoring for the increased future traffic;
- Implementation of traffic noise monitoring; and
- Consideration of a noise barrier along Tran Phu primary school.

Table 17.1 Summary of Environmental Evaluation

No.	Environmental Item	Evaluation	Impacts and Reasons
Social Environment			
1	Resettlement	▲ (C)	About 100 dwellings and about 12 hectares of agricultural lands will be demolished by the project.
2	Economic Activity	△ (C) ○ (O)	Paddy fields and fish ponds will be lost in some portions by the project. However, regional economic activities will be vitalized by the project.
3	Traffic/Public Facilities	△ (C)	The optimum route is designed to pass very close to some public facilities such as primary school.
4	Community Severance	-	The optimum route is planned to avoid passing the densely inhabitant area .
5	Cultural Property	-	The optimum route is keep distance to important cultural property.
6	Rights of Common	-	There are no government regulations for fishery right.
7	Public Health Condition	-	Public health issues will not occurred by the project.
8	Waste	△ (C)	Waste management at construction phase should be considered.
9	Hazards(Risk)	-	Risk of hazards will not increased by the project.
Natural Environment			
10	Topography and Geology	-	As the project scale is not large, change of topography and geology will not occurred by the project.
11	Soil erosion	△ (O)	Mitigation measures for topsoil erosion by rainfall after vegetation removal will be needed.
12	Groundwater	-	Change of the distribution of groundwater will not occurred.
13	Hydrological Situation	-	Change of the river discharge and riverbed condition will not occurred.
14	Coastal Zone	-	The project site is not included in coastal zone.
15	Fauna and Flora	-	There is no endangered/rare species in the project site and the impacts on the existing ecosystem by the project will be very few.
16	Meteorology	-	Change of meteorological conditions will not occurred by the project.
17	Landscape	△ (C) ○ (O)	Although aesthetic deterioration may occurred due to the construction wastes and etc., the bridge's design is taking into account a harmony with local natural view.
Pollution			
18	Air Pollution	△ (C) △ (O)	As the traffic volume will be increased slightly, air pollution caused by the project at construction and operation phase may slightly occurred. Mitigation measures should be considered.
19	Water Pollution	△ (C)	Slight increase in water pollution by the project at construction phase mainly due to construction wastes. Mitigation measures should be considered.
20	Soil Contamination	-	As the construction methods will be considered the countermeasures for soil contamination, the impact will be very few.
21	Noise and Vibration	△ (C) △ (O)	As the optimum route is designed to pass close to houses and existing properties in some sites, the slight traffic noise and vibration impacts by the project should be considered.
22	Land Subsidence	-	As the construction methods will be considered the countermeasures for land subsidence, the impact will be very few.
23	Offensive Odor	-	There is very few factors generating offensive odor by the project.

Note: 1) Evaluation Categories

●: Significant favorable impact is expected. ○: Slight favorable impact is expected.

▲: Significant adverse impact is expected. △: Slight adverse impact is expected

2) (C) = Construction Phase, (O) = Operation/Maintenance Phase

17.5 Proposed Monitoring Programme

Execution of the following monitoring programme is recommended:

Construction Phase

Category	Water Quality	Air Quality	Noise
Location	3 sites	5 sites	5 sites
Period	2 times/week for 5 years	1 day/month for 5 years	1 day/month for 5 years
Sampling Items	pH, SS, COD, BOD, DO, P_{total}, Al, Fe	TSPM, SO_2, NO_x, HC, CO, Pb	L_{eq}, L_{50}

Operation/Maintenance Phase

Category	Water Quality	Air Quality	Noise
Location	3 sites	5 sites	5 sites
Period	2 times/month for 5 years	1 day/6 months for 5 years	1 day/6 months for 5 years
Sampling Items	PH, SS, COD, BOD, DO, P_{total}, Al, Fe	TSPM, SO_2, NO_x, HC, CO, Pb	L_{eq}, L_{50}

18. RELOCATION PLAN

18.1 Action Measures by Steps

The implementation of land acquisition and resettlement mainly consists of the following 10 steps.

1) Establishment of Steering Committees for Implementation and Supervision
2) Socio-economic Survey
3) Valuation for Lost Assets
4) Cost Estimation for the Relocation Programmes
5) Preparation of Alternatives for Compensation and Relocation Site Selection
6) Negotiations about Compensation
7) Relocation Site Preparation with Re-creation of Social Environment
8) Land Transfer and Relocation
9) Monitoring of Execution
10) Coping with Environmental Consequences during Construction Works

The summary of these steps are described in the following together with the conceiving problems and recommendation of the Study Team.

(1) Establishment of Steering Committees for Implementation and Supervision

One of the most critical problem in the land acquisition and resettlement is the provision of compensation budget and seeking financial resources. The budget for relocation Programmes will be allocated by MOT through the evaluation by Hanoi People's Committee after submission of the amount of compensation costs evaluated by the steering committees.

(2) Socio-Economic Survey

The steering committees will be in charge of socio-economic survey to estimate the adequate and accurate population. The names of affected families are recorded immediately based on the results of survey to prevent to inflow of peoples ineligible for compensation.

(3) Evaluation for Lost Assets

The adequate evaluation for lost assets is significant task of steering committees to maintain the living environment of affected people. Consideration for partially lost assets is necessary because remained assets are sometimes economically unproductive.

(4) Cost Estimation for the Relocation Programmes

Compensation cost will be estimated by steering committees in accordance with the regulation of Hanoi People's Committee. Cost estimates must cover all aspects of relocation plan and Programmes, not only the land compensation costs but also resettlement costs and administrative costs, to avoid cost over-run and shortage of budget.

(5) Preparation of Alternatives for Compensation and Relocation Site Selection

The steering committees have a basic policy that the living environment has to be restored at least as same as original living standards. The resettlement sites are provided with infrastructures. Affected people have the right to live on the resettlement sites, however some may prefer to sell the right and move to somewhere by themselves.

(6) Negotiations

Expected major problems in this step are: miscommunication between steering committees and affected people; and poor participation in the resettlement process of the affected and host communities.

(7) Preparation of Relocation Site with Re-Creation of Social Environment

Restoration and improvement of the social environment is one of the most important policy for resettlement of the steering committees. Infrastructures and social services should be provided on the resettlement sites at least same levels of former dwelling. It should be considered that neighboring people or communities also enable to obtain the provided social services for their integration.

(8) Land Transfer and Relocation

The steering committees tend to relocate from the families who accept the compensation terms. However this fragmentary transfer may enhance risks for relocated people in the rehabilitation of living environment. Timely transfer co-ordinated with time tables of civil works should be carried out.

(9) Monitoring of Execution

It may occur that relocated people are neglected during the moving and rehabilitating their living environment. Then monitoring and communication by steering committees should be continued during implementation stage of relocation Programmes to avoid negligence toward the relocated people.

(10) Coping with Environmental Consequences during Construction Works

In the stage of execution of civil works, consequent troubles (noise, dust, vibration, cracks in the wall and etc.) and other unexpected troubles may occur. The steering committees have to take care of such situations, and submit and provide budgets for extra compensation beforehand.

18.2 Affected Sites and Relocation Policy

The alignment of SHTRR has been carefully designed to avoid relocations of resident and buildings. However some areas are unavoidable on the current design alignment, therefore the design has to be adjusted in detail design stage (Table 18.1 and Figure 18.1).

Unavoidable sites and properties should be compensated and relocated in accordance with the regulation of Hanoi People's Committee.

18.3 Land Acquisition and Resettlement Cost

The summary of estimated land acquisition and resettlement cost in the Project is shown in Table 18.2.

Table 18.2 Summary of Estimated Land Acquisition and Resettlement Cost

Compensation Items		Costs (Million VND)	Note
Compensation	1) Land compensation	20,890	
	2) Houses compensation	35,705	Level II or III
	3) Other building compensation	8,205	Graveyard included
	4) Crops compensation	5,376	
	Compensation total	70,176	
Subsidy	5) Personal subsidy	2,304	
	6) Business or trade subsidy	202	
	7) Assistance for recovering	8,794	
	8) Assistance for moving	281	
	Subsidy total	11,581	
Compensation and subsidy total		81,757	
Infrastructure cost for the resettlement sites		20,145	
Administration costs		4,087	5% of the compensation and subsidy costs
Allowance		11,878	
Grand Total		117,867	

Note: Refer to Table 14.2 in Section 14 for estimated cost by each package.

Table 18.1 Major Affected Sites and Properties on SHTRR

No.	Sites	Quantity	Note
1	· Housing sites (dense)	115 houses	along the NH1
2	· Underground water exploitation company · Transport company	several buildings would be partially affected	along the NH1
3	· Office buildings · Housing sites (lined)	70 houses	along the Phap Van street
4	· Housing sites (scattered)	100 houses	along the Phap Van street
5	· Truck garage		along the Phap Van street
6	· Concrete factory		along the Phap Van street
7	· Treasury	2 storey building	along the Phap Van street
8	· Housing sites (dense)	60 houses	along the Phap Van street
9	· Housing sites (scattered)	55 houses	
10	· Housing sites (denser)	40 houses	a part of quarter
11	· Church	1 church	very close to the alignment
12	· Warehouses	3 small houses 2 larger houses	partially affected
13	· Housing sites (denser)	140 houses	a part of quarter
14	· Housing sites (dense)	20 houses	along the Mai Dong street
15	· Housing sites (scattered)	20 houses	close to Gia Lam dike
16	· Graveyard	3 graves	
17	· Housing sites (scattered)	10 houses	surrounded by rice paddy
18	· Housing sites (lined)	10 houses	along the NH5
19	· Beverage factory	2 workshops	partially affected

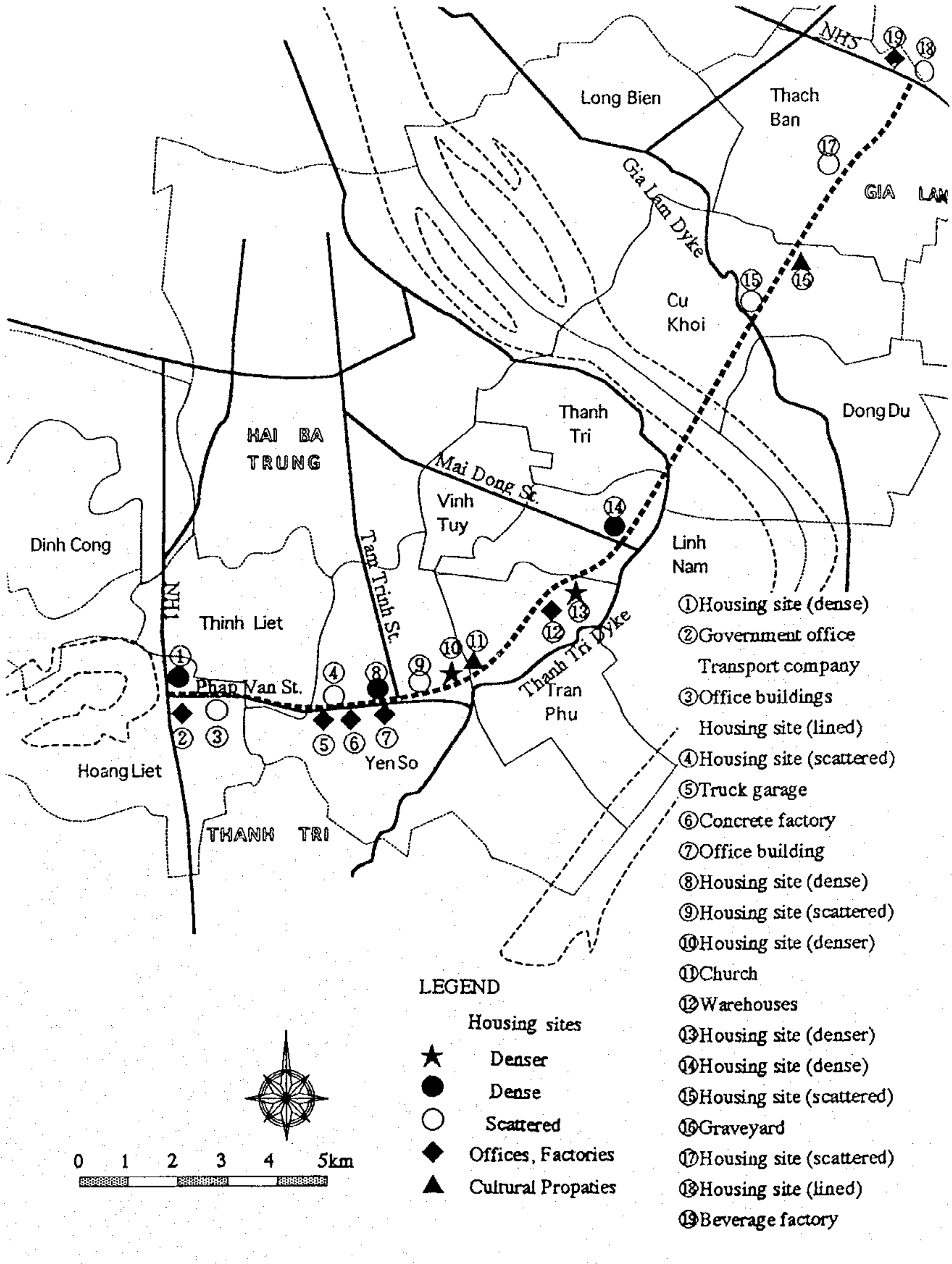


Figure 18.1 Major Affected Sites on SHTRR

19. CONCLUSION AND RECOMMENDATIONS

19.1 Necessity of the Project

The Project, which is to construct Thanh Tri Bridge and Southern Section of Hanoi Third Ring Road (SHTRR) is of great importance for the development of Hanoi capital region and is expected to play the following important roles:

- To improve and strengthen the road network in Hanoi capital region to cope with the future increase in vehicle traffic demand and rapid development in the region;

- To provide a by-pass road of national highway No. 1, since the existing roads in Hanoi central business district are seriously congested, especially in national highway No. 1 corridor; and

- To encourage increase in the traffic handling capacity of bridges crossing the Red River as a whole.

19.2 Future Traffic

The analysis of the socio-economic framework predicts that in the direct influence area of Hanoi city, the estimated total urbanized area in 2020 will become about 3.1 times that of 1997 and Gross Regional Product in 2000 is projected about 2.5 times that of 1990 at 1998 constant prices.

Under such a situation future traffic volume on Thanh Tri Bridge was forecast 73,100 PCU/day in 2010 and 111,700 PCU/day in 2020.

19.3 Conclusion in Technical Aspects

(1) Route

Three route alternatives were studied (Alternatives 1, 2b and 3). As a result of the comparison, it was concluded that Alternative-3 (least land acquisition effort scheme) is superior to other alternatives and selected as the optimum route.

(2) Type of Thanh Tri Main Bridge

Continuous PC box girder bridge scheme and PC cable stayed bridge scheme were examined in detail based on the comparative bridge design and economic analysis. PC cable stayed bridge scheme was not selected as an optimum scheme because of higher cost compared with continuous PC box girder bridge scheme and economic analysis revealed that PC cable stayed bridge scheme is not economically feasible.

(3) Major Design Features

1) A 100 km/hr design speed will be applied as a urban expressway in flat terrain.

2) Lane width of the expressway (through traveled way) is 3.75 m with 3.0 m outer shoulder width and 1.0 m inner shoulder width.

3) Number of lanes of through traveled way in each construction package segment is shown in the following table.

Package No.	Section	Number of Lane
1	Thanh Tri Bridge	6
2	Thanh Tri Section of SHTRR	4
3	Gia Lam Section of SHTRR	4

4) Five interchanges, NH-1 IC (half cloverleaf), New NH-1 IC (Y-type), two dyke road IC (half diamond) and NH-5 IC (half cloverleaf) will be provided.

5) A barrier type toll gate will be provided in Package-3 section.

6) Flexible pavement was designed with a view to lower initial investment cost, better adoptability in embankment section and more comfortable riding condition than rigid pavement.

19.4 Project Cost

The Project cost is 4,465,037 million Dong in January 1998 prices as shown below:

Unit : Million Dong

Package No.	Section	Project Cost
1	Thanh Tri Bridge	2,928,955
2	Thanh Tri Section of SHTRR	1,067,111
3	Gia Lam Section of SHTRR	590,523
Total		4,586,589

19.5 Results of Economic Analysis

The analysis followed the conventional discounted cash flow methodology in determining the EIRR, NPV and B/C ratio. The economic benefits quantified were the savings in vehicle operating and time costs. These results indicated that the Project is economically feasible.

Benefit cost ratio discounted at 12%	1.12
Net present value discounted at 12 %	329,449 million Dong
Economic internal rate of return	13.14 %

19.6 Results of Financial Analysis

Financial analysis is carried out for i). Project implementation by the Government and ii). Project implementation by private sector.

Two cases of toll levels are used for the estimation of revenue calculation as follows:

Case 1: To keep the same toll/users' benefit ratio of 45.2 % (present average of Thang Long bridge) until year 2020.

Case 2: To gradually increase toll/users' benefit ratio from 45.2 % (year 1998) to 70 % (year 2020).

The result of financial study revealed the following conclusions:

i) Project Implementation by the Government

Case 1: Obtained FIRR of 2.83 % is lower than the average interest rate of 4.61 % and judged to be financially not feasible.

Case 2: FIRR shows 5.64 % which is higher than the average interest rate of 4.61 % and the Project is judged to be financially feasible.

ii) Project Implementation by Private Sector

Cases 1 and 2: Calculated FIRRs are 2.80 % and 5.63 % for Case 1 and Case 2 respectively. These FIRRs are far lower than the average interest rate of 8.50 % and judged to be financially not feasible.

19.7 Recommendations

(1) Implementation of the Project

The results of the Study indicate that the Project is technically sound (no serious technical difficulty is anticipated for the construction) and economically feasible. Taking into account the direct and enormous indirect benefits towards regional development other than the quantified savings in travel costs, the Project should be implemented at the earliest opportunity.

(2) Land Acquisition and Resettlement

Delay of implementation would entail increasingly difficult land acquisition and resettlement due to the rapid development of the region, especially in Thanh Tri area. Arrangement of land acquisition and resettlement should commence immediately.

(3) Project Implementation Schedule

Proposed implementation schedule is to emphasize simultaneous commencement of services in all three construction sections, subject to due consideration on inevitable lead-time for land acquisition and resettlement, to optimize investment schedule.

(4) Construction Scheme for Thanh Tri Bridge

Such a stage construction scheme as widening from four lanes to six lanes in due time will entail diverse technical difficulties when applied to Thanh Tri Bridge. Thus it is recommendable to provide whole six lanes in the initial and single construction stage.

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